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THE USE AND ABUSE OF THE IONIC THEORY[1]

TWENTY-FIVE years have elapsed since Arrhenius advanced the theory that acids, bases and salts in aqueous solution are dissociated into their constituent ions. Now that the storm of contention aroused by this doctine is clearing, it may not be inappropriate to consider in cooler blood this proposition of Arrhenius, to reinspect the foundations, and to weigh without prejudice the pros and cons, the successes and failures of the ionic theory.

To show that an electrolyte in solution suffers a change analogous to dissociation, Arrhenius brought forward evidence of three different kinds. First, he pointed out that the various methods of determining molal concentration in solution (freezing-point, boiling-point, vapor pressure, osmotic pressure), all of which are identical in principle and yield nearly identical results, indicate that in a salt solution the number of molecules dissolved, or less hypothetically the number of mols, is greater than the number calculated from the simple chemical formula of the salt.

The second argument rests upon the observation that in an aqueous solution of a strong electrolyte the properties are purely additive. Thus a dilute solution of hydrochloric acid has no properties which are peculiarly its own. It tastes sour, turns litmus red, dissolves metals, inverts sugar and possesses a number of other well-known properties, all of which are possessed in some degree by every acid. Moreover, it precipitates silver and mercurous salts, and

[1] Address of chairman of the Section of Physical Chemistry, Baltimore, December 29, 1908.

exhibits other properties which are found in all chloride solutions. In other words, the solution has no properties which are not included in one of two distinct sets, one possessed by all acids, and one by all chlorides. So it seems natural to regard this solution as a mixture of two substances, hydrogen ion, which is present in all acids, and chloride ion, which is present in all chlorides. To illustrate this additive property let me perform this simple and familiar experiment. Here are two solutions in alcohol, one containing cobalt nitrate, the other an equivalent amount of cobalt chloride. One is red, the other a brilliant blue. On pouring these two into equal large volumes of water, the difference in color disappears and both assume the pink color which is typical of aqueous cobalt solutions. Here again are three copper salts, nitrate, chloride and bromide, which in alcohol are respectively blue, green and dark brown, but when poured into equal volumes of water all show the same blue color of the cupric ion.

Finally, the third main argument in favor of ionization is derived from the electrical properties of solutions. Some fifty years ago Clausius believed that the conduction of electricity in electrolytes affords sufficient evidence to show a dissociation into ions. Whether or not we accept this proof, which is perhaps a little metaphysical, other experimental facts such as Kohlrausch's law of the additivity of conductivities at infinite dilutions, the agreement between conclusions drawn from conductivity and transference experiments, and the coincidence in the degree of dissociation calculated from conductivity and from freezing point, all give strong support to the theory of ionic dissociation.

Unfortunately, some over-enthusiastic advocates of the ionic theory, not content with this solid evidence, have superimposed on the theory other extraneous speculations which, when later discredited, have in some quarters brought the parent theory into disrepute. For example, I may mention the *dictum* that all chemical reactions in aqueous solutions are ionic in character, a notion which not only is intrinsically improbable upon theoretical grounds, but has been refuted experimentally by the experiments of Kahlenberg and others. Some too zealous ionists have applied the theory to highly concentrated solutions, without making allowances for the deviations from the laws of the perfect solution which are to be expected there. It would be absurd to class as a dilute solution one which is five or ten times molal, yet we see attempts to apply to a pair such as sodium and potassium nitrates the law of solubility lowering which has been obtained for ideal solutions.

In justice to the author of the ionic theory, it should be noted that he has had no part in these attempts to stretch the theory beyond its elastic limit. In his papers on this subject, brief as they have been, Arrhenius has with great fairness and extraordinary acumen stated, as far as our present limited knowledge permits, the truth, the whole truth, and nothing but the truth about ionic dissociation.

Against the excess of zeal in some advocates of the theory may be balanced the dogmatism of others who for *a priori* reasons have declared it absurd that a substance like potassium chloride, bound together presumably by an enormous affinity, could break spontaneously into its constituent parts. Instead of attempting to refute such circular reasoning, let us return rather to the consideration of that experimental material upon which are based the three main arguments for the ionic theory. Here a careful scrutiny reveals facts which, disconcerting as they may be, no fair advocate of ionic dissociation can afford to ignore.

The first of these unpleasant facts is that the values for the degree of dissociation of strong electrolytes calculated on the one hand from freezing points, and on the other from conductivities, while usually fairly concordant, frequently differ by an amount far greater than the experimental error. For half normal solutions of lithium chloride, magnesium chloride and calcium ferrocyanide, the degrees of dissociation calculated from the freezing points are 94 per cent., 99 per cent. and 2 per cent., while from conductivities we calculate 71 per cent., 62 per cent. and 20 per cent., respectively. Of course these are moderately concentrated solutions and at higher dilutions the discrepancies become less. Moreover, it is not unlikely that the attempts to explain such facts, by assumptions of hydration, association, and the like, may ultimately be successful, but in the meantime these facts can not be neglected.

In the second place, the additivity of the properties of electrolytic solutions, striking as it is, seems to prove too much. If it is an argument for the dissociation of electrolytes, it seems to be an argument for complete dissociation. Why should the properties of a normal solution of potassium chloride be simply those of potassium and chloride ions if, as measurements of conductivity show, it is 25 per cent. undissociated? Why should the undissociated part have no individual properties of its own? It is easy to see why completely dissociated acids and bases should give the same heat of neutralization, since we regard this heat as simply due to the union of hydrogen and hydroxide ions, but half-normal potassium and sodium hydroxides give essentially the same heat of neutralization with an acid, although they are 20 per cent. undissociated. Half-normal barium hydroxide gives the same, although 40 per cent. undissociated. Copper sulphate as dilute as one tenth normal is still more than half undissociated, but its color is nearly the pure color of cupric ion. Indeed in all the strong electrolytes the partial volume, heat capacity, internal energy, viscosity, refractive index, rotary power, in fact practically all the significant physical properties of the undissociated part of the electrolyte, seem practically identical with the properties of the constituent ions. If we had no other criterion for the degree of dissociation, these facts would undoubtedly lead us to regard salts, up to a concentration of normal or half normal, as completely dissociated.

Finally, the phenomena of electrical conduction present several puzzling, and as yet unexplained, features. For example, attention has recently been called to the interesting fact that the two ions which in aqueous solution possess by far the greatest mobility, are the ions of water itself, hydrogen and hydroxide. This might possibly be regarded as chance if it had not also been found that in other solvents a similar condition exists. Thus in methyl alcohol, the methylate ion moves with unusual velocity. To explain this curious fact, it has been suggested that the ions of the solvent have a mode of progress different from that of other ions, due to their ability to pass *virtually* through the molecules of solvent. This view, in a certain sense, requires a return to a modified Grotthus theory, and if accepted, necessitates the conclusion that the process of conduction is not quite so simple as it may have seemed to the original advocates of the ionic theory.

Perhaps the most vulnerable point in the whole armor of the ionist is reached when we attempt to apply the mass law to the dissociation of strong electrolytes. The mass law derived rigorously only for the perfect solution could hardly be expected

to be exactly true in the case of actual solutions. We might therefore expect certain small deviations from the mass law, but are in no way prepared for the startling discrepancies which are in fact observed. This discrepancy is sufficiently marked in the case of salts of the simplest type, like potassium nitrate or sodium chloride, but is most striking in the case of some salts of a higher type. The following table gives for three electrolytes the values of the "mass law constant" (K) at different molal concentrations (C). We see that when the concentration changes one thousand fold, K changes one hundred fold in the case of potassium chloride and one million fold in the case of potassium ferrocyanide! For the weak electrolyte, acetic acid, it is a real constant.

Acetic Acid		KCl		$K_4Fe(CN)_6$	
C	K	C	K	C	K
.001	.00177	.0001	.0075	.0005	.7
.004	.00180	.001	.035	.002	18.0
.01	.00179	.01	.132	.012	1171.0
.02	.00179	.1	.495	.1	41190.0
.1	.00180	1.0	2.22	.4	842100.0

This extraordinary divergence from the mass law, of which I have chosen the most extreme case known in aqueous solution, is, however, found to an even more startling degree in the case of non-aqueous solutions. To the extremely bizarre conductivity curves there obtained few have had the temerity to apply in full the principles derived from the ionic theory. Nevertheless, we are beginning to realize that the phenomena of aqueous solutions are but special instances of the widely varying phenomena occurring in other solvents; and it seems unlikely that a satisfactory understanding of the behavior of aqueous solutions can come except through a careful study of non-aqueous solutions. At present our quantitative knowledge of such solutions is extremely limited, and does not encourage the belief that we have in any sense a final answer to the problem of solutions.

These, then, are some of the weak points of the ionic theory as it stands to-day. If the case were to rest here I am afraid it would be difficult to bring in a verdict for the theory of dissociation. Indeed many scientists, on the basis of such evidence, have decided to close the hearing and to class the ionic theory with other ingenious hypotheses that have failed to stand the test of experience. But these men have not applied the one criterion by which in the end every scientific proposition must be judged—the test of serviceability. After all, what have we said except that the ionic theory is not complete? But perfection is rare in the science of chemistry. Our scientific theories do not, as a rule, spring full-armed from the brow of their creator. They are subject to slow and gradual growth, and we must candidly admit that the ionic theory in its growth has reached the "awkward age." Instead, however, of judging it according to the standard of perfection, let us simply ask what it has accomplished, and what it may accomplish in scientific service.

When we examine a little more critically the unfavorable features which we have mentioned, we find that they enter chiefly in the application of the theory to strong electrolytes. If we consider the weak electrolytes, like ammonia, acetic acid and most of the organic substances, of which a large number have been investigated, we find a remarkably satisfactory state of affairs. For these the mass law has generally been shown to hold with remarkable accuracy. Indeed it is hardly too much to say that every prediction from the ionic theory has been quantitatively verified for all the weak electrolytes which have been carefully investigated. The degrees of dissociation ob-

tained in different ways are in complete accord; the properties are additive only just in as far as the electrolytes are ionized; the electrical properties seem entirely normal. Here, then, is an enormous field in which the whole theory of Arrhenius may be quantitatively applied, with perfect safety, to a wide variety of problems.

Again, in the case of strong electrolytes at high dilution, the theory of ionic dissociation is completely in accord with all known facts. The agreement between transference numbers measured directly and those calculated from the conductivities at infinite dilution is eminently satisfactory. There can hardly be any question that with increasing dilution the ratio of the molal concentration to that calculated when no dissociation is assumed approaches just two for binary, and just three for ternary salts. Is there any other hypothesis which will account for this cardinal fact?

Any valid criticism of the ionic theory must, therefore, be based upon its application to solutions of strong electrolytes at moderately high concentrations. Here the problem is unquestionably one of great difficulty. Even the simple question of determining the true degree of dissociation is one which still permits much divergence of opinion. One of the suggestions which has been made to account for some of the anomalies of the strong electrolytes is that, owing to the change in the mobility of the ions with the concentration, the conductivity is not a correct measure of the degree of dissociation. In some cases, especially in the case of the hydrogen ion, this supposition has indeed been definitely verified. Yet in the majority of cases it seems very unlikely that we may thus explain the extraordinary discrepancies such as those that I have pointed out in the application of the mass law to strong electrolytes. I have shown in another place that while conductivity may not indeed be an absolutely reliable measure of the concentration of the ions, it furnishes, nevertheless, the only way that we have of determining them. Every other method which has been used gives a measure, not of the real concentration, but rather of the escaping tendency, or activity, which may not in all cases be proportional to the concentration. I believe that we shall make no great error in assuming that the degree of dissociation calculated from the conductivities is in most cases substantially correct and that the lack of fulfilment of the requirements of the mass law for strong electrolytes is due to deviation of one or more of the dissolved substances from the laws of the perfect solution. This assumption is by no means inherently improbable. In fact, in the case of many non-electrolytes we find marked deviations from the ideal laws even at small concentrations.

If we must conclude that one of the substances present in a solution of an electrolyte is abnormal in its behavior, we are inclined at first to suspect the ions, which on account of their peculiar electrical condition might be expected to differ materially from ordinary substances. But this view proves to be untenable. As far as we can judge, the ions seem to obey, at least to a fair degree of approximation, the laws of the perfect solution, and thus we are forced to place the responsibility for the observed anomalies chiefly upon the undissociated part of the electrolyte.

The correctness of this idea may be tested by applying the simple laws of solutions to those cases where the properties of the undissociated substances may be eliminated from consideration. Every such test, which our present experimental material permits, substantiates this hypothesis. Thus, for example, when we consider the equilibrium between a dissolved salt and the ions in its saturated solution we need not consider the undissociated portion. Assuming that the

ions are normal in behavior, we are led at once to the principle of the constancy of the solubility product, the substantial correctness of which has been demonstrated by the experiments of Noyes, and the more recent work of Stieglitz. An entirely similar method which depended upon the elimination of the undissociated electrolyte was employed by Rothmund in his study of the dissociation of picric acid.

Another deduction which is similarly justified is that the product of the hydrogen and hydroxide ion concentrations is a constant, in any dilute aqueous solution, and this important constant has been obtained by several independent methods, all in excellent agreement. Finally the Nernst equation for the electromotive force of a concentration cell gives very satisfactory results when we consider only the ion concentrations. If, however, we apply an equation similarly obtained to the undissociated portion of the electrolyte we obtain results which are by no means corroborated by experiment.

A few years ago I had occasion to make a calculation which involved simultaneously the application of all the principles which I have just enumerated, the Nernst equation, the solubility product, the dissociation constant of water. By the aid of these it was possible to calculate from the decomposition pressure of silver oxide the potential of the oxygen electrode. The potential thus obtained differed more than one tenth of a volt from the value previously accepted, but was in perfect agreement with the results of the independent investigations published during the same year by Haber and by Nernst. The calculation would obviously have been vitiated if any one of the principles used had been unreliable.

To review the service rendered by these simple generalizations deduced from the ionic theory would be to summarize a very considerable part of the exact work in physical chemistry published during the past two decades. In the study of chemical equilibrium and reaction velocity, especially in the process of rationalizing quantitative analysis, these principles are of daily service.

While therefore many difficult problems relating to the application of the ionic theory remain to be solved, this theory must even at the present time be regarded as established on a sound working basis. Advance will come through the exact quantitative study of the properties of aqueous, and especially of non-aqueous, solutions. After this work is completed it is not improbable that our views of the nature of solutions will be greatly changed, but I venture to predict that the later and better theories will not be substitutes for, but rather developments of, the simple hypothesis of Arrhenius.

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THE COLLEGES OF THE UNITED STATES AND THE CAMPAIGN AGAINST TUBERCULOSIS[1]

THE colleges and universities of the United States are social forces of such power that the campaign against tuberculosis can not ignore them: it needs their help, it seeks to enlist them among its strongest allies. And the campaign is so reasonable, so timely, and already so efficient, that it may confidently expect the cooperation of the colleges of the country, as, indeed, it depends on the cooperation of all intelligent men and women interested in the betterment of man.

First in importance among the aids which the higher schools are giving is perhaps the investigation of fundamental

[1] Read before the International Congress on Tuberculosis, Washington, D. C.

problems. It is largely in the universities that the problems which come under the cognizance of this section of the congress—problems of hygiene and sanitation, of economics and sociology—are being solved, and it is here that students of the subject are trained in special methods of research. As examples of various lines of investigation carried on in the higher schools, I may mention the advanced courses in social economics under Dr. E. T. Devine, at Columbia University, where in 1908 an entire term was devoted to seminar work on the social aspects and control of this disease; the investigations of Professors Fisher, Baily and Farnham, of Yale, in diet and housing in sanatoria, and in the relation of tuberculosis to labor and tenement conditions; the sociological work at the University of Chicago where students accompany patients of the college dispensary to their homes, together with the regular visiting nurses and physicians and study local conditions and surroundings and the methods employed in improving the environment; and the work of the University of Wisconsin whose classes from the departments of political economy and sociology visit Milwaukee to study the social and industrial aspects of the disease. In not a few colleges students are securing valuable data as to some of the simpler problems of the local fields of the college or of their home towns and counties, such as the number and proportion of deaths from tuberculosis, the recurrence of the disease in infected houses, the average length of the disease, and its economic losses. From answers to a questionnaire sent to two hundred representative higher schools of the United States, it is found that about one fifth are engaged in investigative work in tuberculosis.

The higher schools are also furnishing from their faculties not a few men of knowledge and conviction as leaders in the propaganda. The lists of officers of this congress, of the National Association and of the state leagues and state boards of health show that the colleges are supplying at least their full quota for this purpose.

A most effective help which the colleges are giving in the fight is along educational lines. In states where the commonwealth does not furnish lecturers for the educational campaign, the work of arousing and teaching the people from the platform falls largely on the schools. University extension courses, summer chautauquas and more incidental occasions furnish a means of reaching the people which Phillips and Garrison might have coveted in their campaign against slavery. The subject of public health receives an interested hearing everywhere, and on this theme the college man speaks with an authority and influence enhanced by his institutional relations. And to college men the educational campaign makes a specially strong appeal. We can not see the people perish for want of knowledge, knowledge which it happens to be our good fortune to possess, and not be stirred by some missionary zeal to go forth and preach the gospel of sanitation and the salvation which it offers from disease. University extension lectures on tuberculosis are now offered by at least fifteen colleges and universities.

A still more fruitful field lies within the college walls. In our students we find an exceptional receptivity to new truth. The stolidity of ignorance, unable to apprehend fundamental principles, the inertia of long-fixed habits of thought and will, the prejudice of financial interests imperiled—none of these obstacles are present in the college. Surely that warm-hearted enthusiasm of youth, easily stirred to noble ends, which in our civil war sent forth to battle the boys of the colleges of North and South

alike, may be aroused to serve in a campaign whose purpose is not to destroy life but to save it.

Some of our colleges are teaching by example the prophylaxis of the disease in the way of bacterial cleanliness. At Dartmouth the class rooms, dormitories and chapel are examined every two weeks by the exposure of gelatine plates, and when the number of bacteria which fall on these plates during ten minutes exceeds forty, the rooms are thoroughly disinfected with formaldehyde. Since the adoption of the wholesale method of disinfection the sickness among the students has been very markedly reduced, especially those mild forms of disease such as pharyngitis, tonsilitis, measles and ordinary colds. In a number of schools immediate attention is given to any suspicious cases of incipient tuberculosis. Colleges whose class rooms are well ventilated, which occasionally test them for the proportion of carbon dioxide present, teach the value of fresh air in the most emphatic way. And the schools whose aim is not the making of a few overspecialized athletes, but rather the physical well being, the maximum efficiency of all their students, inspire an ideal of vigorous health which translated into life becomes the best possible prophylaxis against tuberculosis.

As a matter of education, as well as for stronger reasons, a number of colleges have prohibited the rooming of students in families afflicted with tuberculosis and in houses where the occurrence of such cases has not been followed with disinfection. Where there are state or municipal regulations requiring registration and supervision of cases and prompt disinfection of houses after death or removal, and where these rules are rigidly enforced, there may be little need of college rules. But the replies to our questionnaire indicate that such municipal or state regulations obtain in less than half of college towns and in a still smaller number are they effectively enforced. Apparently in the majority of our higher schools no control is exercised on this vital matter. The young student comes to the college town a stranger, utterly ignorant of the sanitary conditions of the houses of the town among which he is to choose his home. Very possibly he is ignorant of the causes of tuberculosis and sees no danger in joining a family infected with it. He is thus allowed to place his life in hazard without even a remonstrance from those who are supposed to have his physical well being in their charge and who with no great difficulty can usually know of the special places which form the ambushes of the disease. The reason why such regulations are not more widely made is in part the general exemption of college students from serious diseases. But before this reason is held sufficient, an examination should be made into the mortality from tuberculosis of the younger alumni, a mortality which is often high, and which in some instances may possibly be found significant of conditions in the environment of the college. The following from a correspondent in one of the large universities of the middle west may represent the attitude of many schools:

> I believe that there are no faculty regulations at the present time, but the committee on hygiene has considered the matter and expects to inaugurate an active campaign in regard to this with the next school year. There has been so little trouble of this sort among university students that the need has not seemed urgent heretofore, but as matter of education I am personally very strongly in favor of it.

Among the matters which make for the education of the student as to tuberculosis is the use of the tuberculin test with the dairy cattle kept by agricultural colleges and by a number of schools for the use of

their boarding halls. The regular inspection of such dairy herds, reported by a number of colleges, is a duty so obvious that its neglect will go far to neutralize the most efficient teaching of the class room.

Our colleges are using the directest means of enlisting their students in the war against the great white plague. Local anti-tuberculosis societies are organized, as at Radcliffe. Special lectures or courses of lectures are given before student assemblies. At the Rose Polytechnic and at Bryn Mawr such addresses are given by the president. At Vanderbilt University the director of a tuberculosis exhibition held at Nashville was obtained to address the students. At Cornell College, Iowa, the Science Club for four successive years has provided open evening lectures for students and towns-people, securing for this purpose the state bacteriologist, the state lecturer on tuberculosis and one of the government meat inspectors from one of the cities of the state as well as physicians and teachers of the town and college. In about one fifth of the 200 representative colleges such lectures are now given before student assemblies.

A still larger number of schools give special attention to tuberculosis in the class room. At Dartmouth the physical director gives two or three lectures a year to the freshman class in a course on hygiene. Indiana State University provides instruction on tuberculosis, its causes, results and methods of prevention and cure, in a course of lectures on hygiene given by different members of the faculty and required of all candidates for graduation in the college of liberal arts. Purdue University assigns a large place to the subject in a series of lectures on health and efficiency and Carlton College provides for the same in a course on social problems. The propaganda is carried on in many schools in the departments of biology and hygiene, in sociology, domestic science, sanitary engineering, and economics. The University of Wisconsin for several years has given lectures on tuberculosis in farmers' courses and before various meetings of teachers. The University of Minnesota makes such lectures an integral part in the program of its college of education.

The recent organization of schools of education in the stronger colleges and universities opens a large field for the propaganda. Colleges and universities now supply the majority of high-school teachers. To teach the students of the schools of education in the colleges and universities the facts as to tuberculosis is to disseminate these facts throughout the secondary schools. To enlist college and university men and women in the great crusade is to draw under the same banner the hundreds of thousands of high-school boys and girls who in the immediate years are to be under their instruction.

An educational agency effectively employed in some schools is the circular. The students of the University of Minnesota were recently thoroughly circularized on the subject under the auspices of the anti-tuberculosis committee of the Associated Charities of Minneapolis. At Syracuse University the students have entered so heartily into the campaign that they recently distributed cardboard circulars on tuberculosis printed in five languages to the 25,000 homes of the city.

Perhaps less than one half of our higher schools have as yet actively interested themselves in the twentieth century crusade. Yet even those replies to our questionnaire which confess a total lack of cooperation in the present are often most encouraging in their promise for the future. "It is high time that we devoted some attention to a matter of such vital importance," writes the president of a col-

lege of the middle west. And this from a president of one of the state universities:

I have to say in humiliation that practically nothing has yet been done in this state and in our institution as to tuberculosis. . . . I am going to take up the matter in the university next year. I regard the movement as one of supreme importance and hope to bear my share in the beneficent cause.

What results may we expect from the cooperation of all the colleges when it is once secured? Each year we shall enlist hundreds of thousands of the best young men and women of the country. We shall obtain through them the cooperation of the secondary schools whose teachers they supply. And as our students go out into every city and town and village in the land to take their places as citizens of exceptional influence in their communities, we shall secure the cooperation of the leaders of the future. The harvest sown in the college may be some years in ripening, but it is no less sure.

In summation let me say that we may reasonably ask the college and university to help us by giving instruction on tuberculosis in general lectures before student assemblies and in specific teaching in the class rooms of the social, economic and biologic sciences. We may ask for exemplary sanitation of college buildings, for inspection of college herds, and for care over the health of students by regulations securing immunity from house infection and by the early detection of incipient cases of the disease. We may ask for the exertion of effective influence in securing model sanitary conditions in the immediate college environment and for help in promoting the propaganda throughout the state and nation in every possible way.

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PROPOSED PUBLICATION OF EULER'S WORKS

STRENUOUS efforts are now being made to secure the publication of the complete works of Leonhard Euler (1707–83), one of the most prolific writers of all times on pure and applied mathematics. Euler lived at a time when the differential and integral calculus was still young, and he was most influential in making this powerful instrument of thought more easily available in the various fields of mathematics. The enormous extent of his writings has been a great obstacle in the way of securing a publication of his complete works and has thwarted earlier efforts along this line. From a recent circular issued by the Swiss Society of Natural Sciences, it appears that we may reasonably expect that the publication of this great work will begin at an early date. The following extract from this circular should be of interest:

On the initiative of the German Association of Mathematicians, the International Mathematical Congress, meeting at Rome in April, 1908, unanimously passed the following resolution:

"The fourth International Congress of Mathematicians, held in Rome, regards the publication of the whole collection of Euler's works as an undertaking of the greatest importance, both to pure and to applied mathematics. The congress gratefully welcomes the initiative taken by the Swiss Society of Natural Sciences in this matter and expresses the wish that the great work may be carried out by that society in common with the mathematicians of the other nations. The congress begs the International Association of Academies, and more particularly the Berlin and St. Petersburg academies, of which Euler was so preeminent a member, to support the enterprise in question."

Immediately on the adoption of this resolution the representative of the Paris Academy, Mons. G. Darboux, made known that the International Association of Academies had discussed the Euler question at Vienna in the preceding year, and had expressed entire sympathy with the movement. The correspondence which has since taken place between the president of the Swiss Euler Committee and Mons. Darboux, as also with Herr Lindemann, who had aroused interest in the matter in Vienna, leads us to hope that the support of the Association of Academies will be

accorded to the Swiss Society of Natural Sciences, as desired at the congress in Rome.

At its annual meeting, on August 30, 1908, the Swiss Society of Natural Sciences passed the following resolution, proposed by the Central Committee:

§ 1. The Swiss Society of Natural Sciences is willing to publish a complete edition of Leonhard Euler's works, on condition that this undertaking be adequately supported by the government authorities of the Swiss Confederation and of the cantons, as well as by learned bodies and scientists, both at home and abroad, and that the scientific cooperation required for its accomplishment be forthcoming.

§ 2. The Swiss Society of Natural Sciences entrusts to the Euler Committee in cooperation with the Central Committee the execution of all preliminary work.

§ 3. On the conclusion of the preliminary work a further resolution on the part of the society will be necessary before proceeding to publication.

To § 2 some special remarks were added, the last of which demanded "the creation of a fund, by means of private contributions and subscriptions, for the eventual publication of Euler's works."

The Central Committee and the Euler Committee of the Swiss Society of Natural Sciences have always regarded it as a matter of course that the collection of voluntary contributions should begin in Euler's native land. And we are pleased to be able to announce that this idea has been cordially seconded in all parts of Switzerland. The list is not yet closed, but the subscription will most probably reach the amount of 100,000 francs ($20,000). We accordingly consider ourselves justified in turning now to other countries for their support.

Two distinguished scientific bodies have already set a praiseworthy example in this direction.

In September, 1908, the German Association of Mathematicians decided at their annual meeting at Cologne to hand over 5,000 francs to the Swiss Society of Natural Sciences for the publication of Euler's works. This amount is of great significance when we add that the German Association of Mathematicians was thus devoting one third of all its available funds to the object in question.

The resolution unanimously proposed by the managing committee and warmly recommended by the chairman, Professor Dr. Felix Klein, was accepted by the Cologne meeting in a spirit of noble enthusiasm, unanimously and without discussion. The wording of the reasons given for the motion deserves special notice: "In consideration of the great importance of Euler's ever-fresh works to the whole field of mathematical science, the German Association of Mathematicians hereby declares its readiness to actively support the publication of Euler's works as proposed by the Swiss Society of Natural Sciences and the association places at the disposal of the above-named society the sum of 5,000 francs to be taken from the funds of the association."

Further, in January last, the Paris Academy resolved to subscribe for 40 copies of the Euler edition (payable on receipt of each volume), on condition that it should appear in the original languages. This condition has been recently declared agreed to by the Swiss Euler Committee.

The entire cost of the Euler edition as planned has been estimated, after careful calculation and information received from competent firms, at 400,000 francs ($80,000), against which we may place at least 150,000 francs receipts from the sale of the books. If, as we confidently hope, the example of the Paris Academy is followed, and subscriptions come in in sufficient number, the financial effect would, of course, be more favorable.

We therefore now appeal to the mathematicians in every quarter of the globe and to all friends of the mathematical sciences for support and cooperation. We request them earnestly to procure for us as quickly as possible the subscriptions necessary for carrying out the enterprise, urging especially scientific libraries to become subscribers. The Euler edition will consist of about 40 volumes, and the price per volume will not exceed 25 francs ($5). The yearly expenditure will be thus comparatively insignificant, even if several volumes should appear in the course of the twelvemonth. And surely every mathematician will in future all the more insist on finding Euler's works in any library to which he has recourse, as at present these works are rarely to be met with, particularly in newer libraries, for example in America.

We further appeal to all the great mathematical associations to follow the example of the German Mathematical Association. At the same time, we beg their members to arrange the collection of voluntary contributions. As in Switzerland, so surely in other countries, the insurance companies, the more important technical societies, especially those of civil engineers, and such extensive industrial concerns as are based on mathematical-technical science, will be ready to cooperate for the success of our undertaking. For are

not Euler's works to be classed amongst the greatest of all ages, not only on the subject of pure mathematics, but also for their manifold technical applications!

We are hopeful that our appeal will meet with that interest on the part of all mathematicians which a complete edition of Euler's works may justly claim. So much preparatory work has already been done that it needs now but a comparatively slight effort from individuals and from scientific associations to insure the success of our great plan, the publication of Euler's works!

This appeal is signed by the presidents of the central committee and the Euler committee of the Swiss Society of Natural Sciences. Subscriptions may be sent to Professor F. Rudio, Dolderstrasse 111, Zurich V., Switzerland.

G. A. MILLER

REPORT OF THE COMMITTEE TO VISIT THE MUSEUM OF COMPARATIVE ZOOLOGY

To the Board of Overseers of Harvard College: The committee wish to report that they visited the museum on April 29, and were received by Mr. Agassiz, the director, and by Mr. Henshaw, the curator, under whose auspices an inspection of the collections of the museum was made.

A walk through the museum can not fail to impress the observer with the careful forethought for great simplicity and security of construction, and the thoroughly scientific arrangement and handling of the vast collections therein contained. The architectural arrangement of the various departments is of the simplest character, and one can not but be impressed with the high degree of scientific accuracy displayed everywhere. The material on exhibition forms but a small part of the whole collection—more than two thirds of the specimens being stored for the purpose of scientific study. Among these are many great special collections—for instance, those of the Brazilian Expedition of Professor Louis Agassiz, and those of the numerous dredging expeditions of Mr. Alexander Agassiz, which have been the subject of classic memoirs.

Among the recent acquisitions of the museum which have already been described in previous reports, is the large model of the Bora-Bora coral reefs, which has been carefully prepared under the direction of Mr. Agassiz, and is now cased in the museum. It serves in its own way to commemorate the extensive and fruitful investigations into coral reef formation which he has made during recent years.

There are at present more than 45,000 volumes in the library, which, owing to its scientific value, has become one of Harvard's great possessions. It is eagerly sought out and consulted by students and masters in several departments of science, and not from Harvard alone, but from the whole United States and Canada. This great growth has made it necessary to place the books in stacks, and owing to this somewhat compact arrangement, the facilities for consulting the books are not so convenient as they would be if provision could be made for a more perfect system of artificial illumination.

With the growth of the museum, the need of a number of expert assistants in the preparation and mounting of specimens has been felt.

The first need to which we call attention would not involve great increase in the expenditures, but the second is a large item. As the resources of the museum and the director's private generosity are already taxed to the utmost, it rests with the university itself, or with the public, rather than with the museum, to bear this additional burden. Your committee feel strongly that the university should assume it.

It is appropriate on this occasion to call attention to the fact that this year marks the semi-centennial of the establishment of the Museum of Comparative Zoology. On April 2, 1859, the legislature of Massachusetts voted that the sum of $100,000 should be granted to the Museum of Comparative Zoology. In June, 1859, articles of agreement were made and executed between the trustees of the museum and the president and fellows of Harvard College. A piece of land about five acres in extent was deeded by the corporation to the museum, for the purpose of erecting a

fireproof building. The laying of the corner-stone took place with appropriate ceremonies on June 14, 1859. The formal establishment of the museum took place in October of the same year, by the presentation of Professor Agassiz's collections to the trustees.

The foundation was placed at first in the hands of a body of trustees appointed by the state, and it was not until 1875 that the museum was turned over and placed permanently in charge of the corporation of the university.

A small and lonely looking brick block which was erected at this time, with its four rooms to the floor, has grown nearly continuously around three sides of the great square originally laid out for it. A second section of the museum was soon added to the first, in 1871–2, and further additions were made in 1877, and again in 1880–2, and it was not until 1888–9 and 1901–2 that the last portions of the museum were finally added. The departments of botany and mineralogy and geology which have been added from time to time, and the Peabody Museum of Archeology and Ethnology—the building of which was begun in 1876—form portions of the present structure now known as the university museum, of which the Museum for Comparative Zoology forms the major part.

The university museum contains thirty-two rooms in its ground plan, and is by far the largest building of the university. Nor is it an empty shell—it barely serves to house its treasures and the students thereof.

A glance at the plans of this building shows what grand results have been accomplished in a half-century's work, and what has followed from the inspiration of a great teacher. Intellectually, the institution has grown from the daring experiment of a great enthusiast to an important position among the leaders of the world's museums and laboratories. It is doubtful if any department of the university has brought home to it from the old world more fame, or if any department has done more enduring work for time to come.

It is well to recall these historical memoirs on this occasion, and it must never be forgotten that such progress and development would have been impossible without the lifetime devotion of two very remarkable men—father and son. One is gone; in his life and death he has had great praise. He deserved it, and the university should ever commemorate him. One is with us; we should not wait until he is gone to give praise to him. He is a major benefactor to the university, and a great figure in her history. To him the university owes not only a lavish fortune spent in her service, but much more than this—the lifework of a great administrator, and a great scientific man.

Your committee, therefore, are unanimously of the opinion that this fiftieth anniversary of the Museum of Comparative Zoology should be fittingly celebrated by the whole university, and, further, that no celebration could be so fitting as one which would evince the university's admiration of the scholar and the man —Alexander Agassiz. It strongly recommends, therefore, to your board timely and positive steps in this direction, and tenders its services if desired for more concrete suggestions or consultation.

J. COLLINS WARREN,
Chairman

May 12, 1909

SCIENTIFIC NOTES AND NEWS

COLGATE UNIVERSITY has conferred its doctorate of laws on Dr. E. F. Nichols, president-elect of Dartmouth College. Dr. Nichols was professor of physics at Colgate University from 1892 to 1898.

WILLIAMS COLLEGE has conferred its doctorate of laws on Professor H. B. Fine, professor of mathematics at Princeton University.

THE degree of LL.D. has been conferred by the University of North Carolina on Dr. R. H. Whitehead, the new dean of the medical department of the University of Virginia.

ON the occasion of the Health Congress to be held at Leeds in July the honorary degree of LL.D. will be conferred by the university on the president of the congress, Col. T. W. Harding, and the honorary degree of D.Sc. on Sir

James Crichton-Browne and Major Ronald Ross.

The French Institute has awarded the Osiris prize to M. Louis Blériot and M. Gabriel Voisin, the aeronauts and engineers, in recognition of their achievements and experiments in aerial navigation. The prize, which is of the value of £4,000, is awarded every three years to the person or persons who during that period shall have made the most remarkable contribution to the cause of human progress.

The Pharmaceutical Society has awarded the Hanbury gold medal to Professor W. O. A. Tschirch, professor of pharmacognosy and practical chemistry at Berne University.

Sir Felix Semon, K.C.V.O., physician extraordinary to the king, is about to retire from practise, and a complimentary banquet is to be given him by his professional and other friends on July 2. The organizers of the banquet are anxious to found a lectureship or scholarship in his name to be a record of his scientific work.

We learn from the *Journal* of the American Medical Association that Professor A. Tamassia, of the chair of medical jurisprudence at the University of Padua was recently elected member of the Italian senate, and his election and the thirtieth anniversary of his connection with the university were celebrated simultaneously on May 29 by the presentation from the citizens, faculty and students of parchment testimonials, a gold medal, a bust of himself and a banquet.

Dr. Gottfried Galle, the eminent astronomer, who since his retirement from Breslau twelve years ago, has been living in Potsdam, has celebrated his ninety-seventh birthday.

Dr. Edward Pflüger, the eminent physiologist, has been made an honorary citizen of Bonn, on the occasion of his eightieth birthday.

Dr. Samuel C. Chew, professor of medicine in the University of Maryland, has resigned his position, which he has held for nearly forty-five years.

Professor Lloyd Tanner, M.A., D.Sc., F.R.S., has resigned the chair of mathematics in Cardiff University College, after twenty-six years' service.

The German Physiological Society has been meeting at Würzburg, under the presidency of Professor Max von Frey.

Frederic Walton Carpenter, Ph.D., has been appointed by the president and fellows of Harvard College to be director of the Bermuda Biological Station for Research for the summer session of 1909.

Dr. Ralph Arnold, geologist, U. S. Geological Survey, formerly of Washington, D. C., resigned on June 1 and moved to Los Angeles, California, where he expects to continue his scientific investigations in connection with professional work as a consulting geologist and engineer.

Mr. H. Helm Clayton has resigned as meteorologist of the Blue Hill Meteorological Observatory, with which he has been connected for many years. Mr. Andrew H. Palmer, a graduate student of meteorology at Harvard University, has joined Professor Rotch's staff.

Mr. Pierce Larkin, A.B., University of Oklahoma, has been elected to a fellowship in the department of paleontology in the University of Chicago. He will spend the summer in collecting vertebrates in the Oklahoma Redbeds.

Messrs. U. S. Grant and D. F. Higgins sailed from Seattle on June 8 for Seward, Alaska, where they will begin a reconnaissance of the eastern part of Kenai Peninsula. They will use a large launch for traveling, as the work will necessitate passing many headlands that are open to the full sweep of the Pacific.

Professor W. E. Stimpson, of the University of Kansas, has received a year's absence to work in the Bureau of Standards at Washington.

Professor Charles Edward A. Winslow, of the biological department of the Massachusetts Institute of Technology, has been granted leave of absence for three months, so that he may take the place of Professor E. O. Jordan, of the University of Chicago, during this fall when he will be in Europe.

Dr. Santiago Roth, of the La Plata Museum, Argentina, has accepted membership on the International Correlation Committee of the National Academy of Sciences. The object of this committee is to obtain data for a better correlation of the geological succession in different parts of the world, a matter in which there is at present wide diversity of opinion. Dr. Roth will contribute especially upon the Mesozoic and Cenozoic formations of the Argentine Republic.

At the commencement exercises of the medical department of the University of North Carolina, Dr. William H. Welch, of the Johns Hopkins Medical School, delivered the address. Dr. Welch has now sailed for Europe.

A statue in honor of Theodor Swann, the physiologist, has been erected at Neusz where he was born.

Professor Carl N. I. Börgen, for thirty-four years director of the Imperial Observatory at Wilhelmshaven, has died at the age of sixty-six.

Dr. Maria Aristides Brezina, formerly director of the mineralogical department of the Imperial Vienna Museum, died in Vienna on May 25, after a long illness, in the sixty-second year of his age. Dr. Brezina was one of the most brilliant and thorough of the European mineralogists. He devoted the latter part of his life to the study of meteorites and he created a vast amount of important literature on the subject, incidentally making the meteoric collection in the Imperial Museum in Vienna the most complete in existence. The mineralogical collections prospered under his direction; indeed, the Viennese collections were for many years the leading ones in Europe. Dr. Brezina leaves a wife, two daughters and a sister.

UNIVERSITY AND EDUCATIONAL NEWS

The mechanical and electrical engineering laboratories of the Rensselaer Polytechnic Institute, erected at a cost of about $400,000 from the fund given by Mrs. Russell Sage, were dedicated on June 15, at the eighty-fifth commencement of the institution. Addresses were made by Jesse M. Smith, president of the American Society of Mechanical Engineers and by Louis B. Stillwell, president-elect of the American Institute of Electrical Engineers.

For the purpose of maintaining at Cornell University a number of students who are to pursue research work in engineering, Mr. L. L. Nunn, of Telluride, Colorado, is building on the campus and will endow a clubhouse in which the investigators that he sends there are to live.

A fellowship in chemistry of the annual value of $500 has been endowed by Dr. Milton L. Hershey, of Montreal, in the School of Mining, Kingston, Ontario. It is open to graduates of all universities and technical colleges.

Mr. Charles Marten Powell, formerly scholar of Corpus Christi College, Oxford, has given £250 a year to the college in order to enable it to augment the stipend of White's professor of moral philosophy, in accordance with the statutes of the last commission.

King Edward will lay the foundation stone of the first new building of the Imperial College of Science and Technology for the departments of mining, metallurgy and geology (Royal School of Mines), and in extension of the engineering department (City and Guilds College), on July 8. The buildings are to be erected on the land in Prince Consort-road, South Kensington, lying to the east of the Royal College of Music and to the north of the City and Guilds College.

At Harvard University Edward Murray East, of the Connecticut Agricultural Experiment Station, has been appointed assistant professor of experimental plant morphology, O. K. O. Folin becomes Hamilton Kuhn professor of biological chemistry, E. E. Southard, Bullard professor of neuropathology and Myles Standish, Williams professor of ophthalmology.

Among the promotions to full professorships at the University of Wisconsin are Dr. Richard Fischer, analytical chemistry, and Dr. H. C. Taylor, agricultural economics. The following were promoted from assistant profes-

sorships to associate professorships: Eliot Blackwelder, geology; C. M. Jansky, electrical engineering, and E. G. Hastings, bacteriology. Those who were raised from instructors to assistant professors include George Wagner, zoology; E. R. Jones, soils; C. P. Norgord, agronomy; M. O. Withey, mechanics; W. S. Kinney, structural engineering, and A. G. Christie, steam engineering.

AT Princeton University Dr. E. P. Adams, assistant professor of physics, has been elected professor of physics and Dr. L. P. Eisenhart, preceptor in mathematics, professor of mathematics. Among the preceptors elected were: P. H. Fogel in philosophy; J. G. Hun, C. R. Maclunes and Elijah Swift, in mathematics. The following instructors were appointed: E. B. Baxter, in philosophy; B. J. Spence, in physics, and C. M. Dennis, in civil engineering.

IN the Johns Hopkins Medical School Dr. Charles D. Snyder, has been appointed associate in physiology. Among the instructors appointed are: Dr. Leonard G. Rowntree, in experimental therapeutics; Dr. Arthur H. Koelker, in physiologic chemistry; Dr. Herbert M. Evans, in anatomy, and Dr. Milton C. Winternitz, in pathology.

DR. JOHN C. SHEDD, of Westminister College, Denver, has been elected professor of physics and head of the department at the University of Pittsburgh. The department will move into the new laboratories now nearing completion. Mr. Will Grant Chambers, for the past five years professor of psychology in the Colorado State Normal School, has been elected to the newly established chair of education in the same institution.

DR. C. H. SHATTUCK, associate professor of botany and forestry at Clemson College, S. C., has recently resigned to accept a professorship in the University of Idaho.

MR. H. P. KEAN, assistant in the University of Illinois, has been elected professor of mathematics in Ripon College.

AT the University of Cambridge Mr. H. F. Newall, F.R.S., fellow of Trinity College, has been elected to the recently founded professorship of astrophysics.

DISCUSSION AND CORRESPONDENCE

JOINT MEETINGS OF ZOOLOGICAL SOCIETIES

TO THE EDITOR OF SCIENCE: There has been brought to my attention much severe criticism of the fact that at the recent Baltimore meeting Section F held meetings parallel with those of the American Society of Zoologists; and many of these criticisms are in such a form as to suggest that the officers of Section F deliberately planned that conflicting arrangement. Such is not the case. The officers then responsible for Section F were also members of the American Society of Zoologists and therefore were especially anxious to avoid conflicting meetings. For some weeks preceding the meeting, the secretaries of the American Society of Zoologists and Section F carried on correspondence looking towards a joint program, with the exception of the vice-presidential address before Section F. In the last days before publication of programs, it suddenly became evident that the large number of papers submitted made a joint two-day program as planned impossible, and there was no time for considering possible rearrangements of plan.

The problems of conflicting meetings have now been more carefully considered by the sectional committee of Section F; and with the hope of leading to better organized zoological meetings, with grouping of papers into natural subdivisions and perhaps sectional meetings when necessary in order to complete the program of papers in two or three days, the committee has voted that if the American Society of Zoologists goes to Boston next December Section F will propose limiting its meetings to the vice-presidential address and business, and leave to the American Society of Zoologists entire charge of the meetings for the reading of zoological papers. Such a proposition has been transmitted to the secretary of the American Society of Zoologists for reference to the executive committee of that society.

The writer has heard only one line of objection to the general plan of this proposition, namely, that Section F has among its members several hundred who are not eligible to

membership in the American Society of Zoologists. This is true and is one of the strongest reasons for the existence of Section F as an organization independent of the American Society of Zoologists. However, so far as experience at meetings in recent years goes, this large membership of Section F has no important bearing on the question of a consolidated program of papers under the auspices of the American Society of Zoologists. There have probably not been a half dozen papers read before Section F in the past three years by authors who were not also members of the American Society of Zoologists or who could not have obtained an introduction to that society for the reading of their papers. Moreover, the sectional committee of Section F has constitutional authority for rejecting papers not satisfactory in preliminary abstracts; and since the members of that committee are also members of the American Society of Zoologists there is no reason to suppose that an irresponsible member of Section F could get an opportunity to read a paper in a consolidated program with the American Society of Zoologists.

A second objection is that the large audiences composed of members of Section F inhibits discussion and as a result zoological meetings are not so helpful as they were years ago. This is absurd to one who observed the record-breaking run of papers made by the American Society of Zoologists at Baltimore on the days when Section F held its own meetings. It is evident that the American Society of Zoologists has already overgrown in scope, in membership and in productivity of members; and soon must consider some natural subdivision in order to gain the time for the deliberate work which was once so satisfactory.

It is true, as charged by certain members of the American Society of Zoologists, that the majority of papers read before Section F are by the younger group of zoologists. But may not these men just entering the zoological field have some right to the inspiration and criticism derivable from reading papers before a body of older zoologists? Have those who object to the reading of papers by the younger men forgotten that ten or twenty years ago they too were just emerging from the graduate schools and were eager to present their research work? The need of an opportunity for those not yet eligible to membership in the American Society of Zoologists is alone sufficient justification for regular programs of Section F whenever the American Society of Zoologists does not adopt some such grouping of papers and parallel sectional meetings as will permit the reading of all zoological papers worthy of serious consideration. If the officers of the American Society of Zoologists are willing to make such an arrangement, the present officers of Section F will cooperate fully in the selection of papers offered by members of Section F who are not also members of the American Society of Zoologists, and after that will leave the programs for reading of papers entirely under the auspices of the officers of the American Society of Zoologists. But if such a consolidation is not acceptable to the American Society of Zoologists, the officers of Section F will continue to consider it their duty to arrange otherwise for the reading of worthy papers by men who do not have an opportunity to present results of their research before the American Society of Zoologists.

Maurice A. Bigelow,
Secretary of Section F
Teachers College,
Columbia University

THE BIRTHPLACES OF LEADING AMERICANS AND THE QUESTION OF HEREDITY

In Science, April 9, I challenged the following statement of Mr. W. J. Spillman:

> With only 29 per cent. of our population actually living on the farm, with miserably poor school facilities as compared with our city population, this 29 per cent. furnishes about 70 per cent. of the leaders in every phase of activity in this country.

In Science, May 7, Mr. Spillman corrects his 29 per cent. to about 36 per cent. He admits that he has "no way of ascertaining how many of the men who are distinctly leaders in this country were actually brought up

on the farm." He also says he merely repeated a statement he had heard frequently and which he had never heard challenged.

Mr. Spillman, however, doubts the significance of the facts which I presented in SCIENCE, April 9, drawn from "Who's Who in America" showing that centers of population of 8,000 and over have produced about twice their expected ratio of persons included in this volume. I do not myself claim that these figures give a final refutation to the belief which Mr. Spillman holds, that there is a special value to be assigned to life on a farm during early boyhood, but there appears to be certainly no evidence at present to support such a view. Future investigation may show that the farms give a higher ratio than the small towns and villages, but the inference from such data as we have is in favor of concentrated centers of population against sparsely settled regions in general. This idea must stand until special researches show that it does not apply to towns and villages against farms. In any event, the actual farms have probably produced much less than 70 per cent. of the total leaders of the present day, since 30 per cent. are found from the cities alone, and this would leave nothing for the towns and villages.

Mr. Spillman's second letter contains so much that requires discussion or correction that I am forced to quote nearly the entire article, taking the points up one at a time.

Although I thank him for his complimentary references to my study of heredity in royalty, still I am sorry that he has introduced this more complicated discussion just here. But since in the first part of his article he has done so, I would like to correct one or two misinterpretations of my position on the question of environment *versus* heredity. Mr. Spillman says:

> I have only one criticism of Dr. Woods's reasoning. In studying heredity in royalty he purposely chose this class because it could be assumed that their characters were formed under the most uniform environment, which purpose was of course entirely legitimate.

This was really not my purpose in choosing royalty as a basis of study; and, furthermore, I do not think that their characters were formed under a uniform environment. I have found in studying their lives the greatest variation in their environments, all the way from the supposed advantages of a wholesome family life, with famous tutors to give them learning, or the call of warfare to grant opportunity, down to the foul atmosphere of some Bourbon court, or the mouldering walls of a prison cell.

On all this I have dwelt in the same book which Mr. Spillman here alludes to.[1] On page 9 I say:

> Although all have the highest social rank, they have lived in different countries, in different centuries, and under varying circumstances, with different educations and opportunities.

The same theme is expressed more fully on page 284, and occurs here and there throughout the whole work.

Mr. Spillman goes on to say:

> But it must be remembered that this [royal] environment is the best possible for the development of character and ability.

I do not see how Mr. Spillman can feel justified in making a positive assertion on this point, so many diverse opinions are held. Besides, it is begging the issue which I raise, that no one has shown that any ordinary civilized environment is more influential than any other in molding the rough outlines of character or determining the end product of achievement. I should say that we have no means of knowing whether the royal environment is on the whole favorable or unfavorable. Some investigators like Jacoby and Galippe, along with journalistic writers, have assumed it to be very unfavorable, though without any satisfactory proof.

Mr. Spillman adds:

> It would be gratifying to me to see Dr. Woods make a similar study of some class of human beings subjected to an unfavorable environment. I believe he would find, as I have stated above, that even in that class native ability and natural impulses would prove to be purely a matter of

[1] "Mental and Moral Heredity in Royalty," New York, Holt, 1906.

heredity; but that character and actual ability would be found to be profoundly modified by environment. In fact, the whole experience of the human race speaks for this assumption. If the opposite were true, then why should the state go to the expense of maintaining schools, for a man's effectiveness would not depend on his environment but upon his inheritance.

I am glad to answer this point because I think that some of the confusion which ordinarily accompanies the discussion of this time-honored question may be lessened; and I should like at the same time to state my own position in the matter. I have never claimed that great alterations in the environment of man would not produce any results.

It is, at the outset, both necessary and easy to recognize that there are in general two ways that a man may stand in relation to his environment. First, it may be an environment from which he can not escape, try as hard as he may; and second, it may be one from which he can escape, if the inherent tendencies are strong enough. These two arbitrary classes may shade into each other at times; but I think it will aid in clearing up some of the usual perplexity which clings about the subject, if I am permitted to formulate these two categories. An accident which affects the brain or sight, a long term of imprisonment, or confinement to a desert island, may serve as examples of environments from which there is no escape. In a like way the same may be said of the epoch, or period of civilization in which a man's life falls. All such environments must *a priori* modify character more than conditions from which there is a ready, or even possible, escape should the innate impulses crave it. Now the complete cessation of all schools of education would be establishing an environment from which there would be no escape. Except that there would still be libraries, it would be like returning to the educational possibilities at the time of the Teutonic tribes. It would be suddenly changing one period of civilization into another. This would of course work a profound detriment to all mankind. But there would still be marked individual differences of achievement.

Now the point is that in any given age, or in any one civilization, there are always these marked differences of achievement or moral character. The question then arises—Are the differences in environment which have ordinarily existed in the past, within any one age, or do exist at the present time, of sufficient magnitude or force to cause evident or measurable differences among men?

At least within modern centuries, and since the days of serfdom, it is possible for a man to pass from one set of surroundings into another if the inborn desires and abilities are strong enough. Thus here we have a condition coming under the head of an environment of the second class or one from which escape is possible, and therefore we do not expect to find environment working at its maximum, as we do for instance in experimental zoology where the conditions are imposed and unescapable. But more important than this general argument is the fact that no one has shown that such variations in surroundings as occur in the average lives of human beings (riches or poverty, good or bad education, etc.) are in any way responsible for the rougher differences found among men. I say rougher differences because it is only into rough grades and scales of difference that psychic qualities have so far been classified by the few investigators who have worked upon such problems. I suppose that even the ordinary variations in circumstances which befall mankind produce some change in character and achievement. I do not know. All I say is that no one has succeeded in demonstrating it. I myself searched for it in the statistics of royalty by five different methods, but failed to find it there. I concluded that the force of environment is in general slight, in accounting for mental and moral differences, perhaps measurable when more delicate methods should be devised. Galton, from a study of twins,[2] places "nature" over "nurture," though only vaguely so; but Thorndike, in his "Measurements of Twins,"[3] goes fur-

[2] "Inquiries into Human Faculty," 1883.

[3] *Arch. of Philosophy, Psychology and Scientific Methods*, No. 1, September, 1905.

ther than Galton, and precisely confirms my own estimate, made in 1902, of about nine tenths for heredity. Barrington and Pearson have recently found that the influence of environment on sight is *nil*.[4] Thus the prediction is already strongly in favor of future investigators arriving at a similar result, that the ordinary influence of environment on the higher human attributes is at most but trifling when the heredity factor remains the same, or when the heredity factor can be measured, or eliminated from the discussion.

Usually it is not possible to separate heredity from environment. We often merely find some correlation which may be explained as due to either or both of these forces. An example of this sort of correlation is the one I found to exist between general superior achievement in the United States and city birth. I have already explained in my other article why some correlation is to be expected from inheritance alone, while from environment it may or may not be expected. No one is in a position to speak on the latter question because no one knows whether, on the whole, the good and bad sides of city life strike a balance in favor of the city against the good and bad sides of country life. And even if the answer to this complicated problem were known, we should not then know if there were anything efficacious enough to produce a measurable result, as I have explained above.

The failure to find a higher ratio for the cities would have been a serious blow for heredity. The finding of a higher ratio for cities merely wards off a possible attack. It is a purely negative defense, and this is all I have claimed for it. Now, in his second letter Mr. Spillman positively asserts: "Dr. Woods's own figures prove the effect of environment as against heredity." In the light of the explanation in my former letter, which I have here just now, in other words, repeated, I ask, How can he possibly know this? How can he know that the figures are even beyond the expectation from the heredity factor alone?

[4] "A First Study of the Inheritance of Vision and the Relative Influence of Heredity and Environment on Sight," *Eugenics Laboratory Memoirs*, V., 1909.

Mr. Spillman then complains that the persons listed in "Who's Who in America" do not represent leaders. I do not wish to enter into a discussion on the use of words, and for the sake of the argument will grant that they shall be called merely "competent workers," but I can not refrain from saying in passing that "leaders" seems a very fair word to apply to a group so small as 16,000 out of a total population of some 80,000,000. I should think of the colonel of a regiment of a thousand as the leader of that thousand and it would be in no less just a way and with as good a proportionate sense to call the higher railroad officials, greater bankers and relatively few doctors, lawyers, etc., whose names are included in this same volume "leaders" in their special fields of activity. But even if we are to call them mere "competent workers," are not just such "competent workers" to be desired, whatever be the cause of their competency?

I knew that "Who's Who" itself would be criticized, therefore I forestalled this criticism by the following:

> Some will not be willing to accept conclusions drawn from a list which like this doubtless has certain flagrant omissions, and where he sees names that he considers should not have been included. If he will stop for a moment and think, he will see that the very objection he raises only argues in the other direction from what he supposes. If, for instance, I find a marked correlation between city birth and more or less notable subsequent achievement, drawn from an imperfect list, the correlation would be even higher were the list of names ideally perfect.

Mr. Spillman makes no reference to this. The same applies whether the list be lower in standard than it should be owing to errors within itself, or whether it be in general a list showing a low standard of selection. Providing of course that the standard be above the general average of the population, then it follows that the higher the standard the higher would be the correlation, at least as far as mathematical expectation is concerned.

Mr. Spillman then takes a prop from the

25 presidents of the United States "23 of whom were country bred, or were brought up under what the census terms rural conditions." This fact is without significance for two reasons. First, the total 25 is so small that the probable error is necessarily too large to give a conclusion in a statistical discussion of this kind. Second, and equally important, their birth records must be taken in terms of the total proportion of the population dwelling in the country and rural districts in the early days when these men were born. The fact that "about 36 per cent. of our population actually live on the farm at the present time" has nothing to do with the question. The same criticism applies to the figures concerning United States senators. He has shown no ratio over the expected for the rural regions in terms of population distribution, at the time of their birth, some fifty or sixty years ago.

I shall look forward with expectancy to the other statistics which Mr. Spillman hopes to present, and am very glad that he takes an interest in these questions. I agree with him that "the matter must rest here until further statistics are available"; but in the meantime I shall feel much confidence in the indications which have been furnished me as drawn from a list of some sixteen thousand, more or less notable persons, out of the vast population of the United States.

FREDERICK ADAMS WOODS

BROOKLINE, MASS.,
May 17, 1909

FAIR PLAY AND TOLERATION IN CRITICISM

To that large number who accept the justice, the value and the need of the recent criticism by Blackwelder of the geological fallacies dressed out as facts in Lowell's book on Mars as the abode of life, some reply will seem called for to offset before the general scientific public the personal, befogging and dogmatic rejoinder which it evoked in a recent issue of SCIENCE from one not a geologist.[1] In this connection some preliminary statement may well be made as to the kind of articles which in the mind of the writer seem to call for certain kinds of criticism. This appears the more necessary since to some all criticism seems out of place and to indicate a carping disposition, while others would hold that specialists are too lax in permitting to pass unchallenged many works which are highly erroneous but whose character is evident to the specialist only.

[1] "Fair Play and Toleration in Science," by T. J. J. See, professor of mathematics, U. S. Navy, SCIENCE, Vol. XXIX., pp. 858–60, May 28, 1909.

Destructive criticism is to all constructive workers in science a disagreeable task, yet one which should often be regarded as a duty, especially to university teachers, since such are deeply interested in the general diffusion of knowledge and should be equally concerned in the prevention of that diffusion of error which, unless vigorously combated, takes the place of truth.

All research work, even by properly qualified men, must necessarily contain some percentage of error which is eliminated by further advances in knowledge, but which frequently serves a most valuable purpose in stimulating to further and more exact observation and analysis. Such work, addressed to specialists, is always worthy of more praise than criticism, and a proper review will always seek out the parts of value and give them more prominence than those features which in the mind of the reviewer may seem open to question or even to miss the truth. It is not such research work which is here under discussion.

Advancement of knowledge, however, implies not only abstruse technical researches, but popular expositions of the same which shall carry a vivid conception of the principles and results to the intelligent but unprofessional public, consisting of laymen as well as workers in other branches of knowledge. Such work when well done is regarded by scientists in general as of the very highest educational value, and many eminent men have contributed a part of their time to the development of popular science. In fact, no small part of the eminence of some of the best known and highly regarded men of science is due to their work in what may be called the popular field, since it reaches those whose professional interests are in other branches. It is obvious

that it is not against work of such character that Blackwelder's review is directed.

Again, there is a large class of fugitive popular scientific literature written by men of no personal reputation, bearing within it the marks of its unauthoritative nature, some of it good, some bad. Such articles hardly call for serious comment from specialists.

But there are popular works ably written and put forth in a garb of authority which, however, confuse facts, theories and hypotheses, and contain views regarded by the great body of those qualified by special knowledge to hold an opinion as outworn, or wholly erroneous and misleading. It is against such false science, not popular science, that public and severe censure becomes a duty. As Blackwelder admirably puts it, unless such criticism is directed against such a book and its author "the average reader naturally believes him, since he can not without special knowledge discern the fallacies. He has a right to think that things asserted as established facts are true, and that things other than facts will be stated with appropriate reservation. This is precisely the same as his right to believe that the maple syrup he buys under that label is not glucose, but is genuine. The misbranding of intellectual products is just as immoral as the misbranding of the products of manufacture."

This code of morality makes it the duty of the teacher and scientist to expose in print such scientific shams, a duty, however, which is always disagreeable and which the majority of men leave to their fellows to do. He whose time is fully occupied with teaching and research, but who turns aside to do the task which others have left undone, is therefore deserving of honor and not of abuse.

It is noteworthy that Lowell's book on "Mars as the Abode of Life," in spite of its mass of fundamental errors whenever geological matters are touched upon, errors palpable to every working geologist, has been before the public for more than a year without any criticism of these features appearing in SCIENCE, the official organ of the American Association for the Advancement of Science, an association which since the development of special societies has become devoted to the general broadening of scientific knowledge. Such a criticism seems especially called for, since the book has been given the very widest publicity, it deals with a subject of great popular interest, and its author has been grandiloquently advertised by his publishers as the "founder of the new science of planetology." As an illustration of the result it may be noted that in the scientific columns of a carefully edited popular weekly its author has been hailed as one who would henceforth relieve America from the European taunt that it had as yet produced no really great and creative man of science.

As an offset, however, to the necessarily severe criticism of "Mars as the Abode of Life," cordial recognition may well be given at the same time to that great enthusiasm manifest in all of Lowell's work, which has led to the founding of a magnificent observatory and has contributed to astronomy much of real value. A coming generation of scientists will find much to regard highly in Lowell and will see in his work a stimulus to further knowledge, but will hold it as unfortunate that the same temperament which led to these results should have given rise to writings which called forth such severe criticisms as have appeared from his contemporaries in order to separate errors of premise and conclusion from that which is of real value.

Having made these preliminary statements, the true character of See's arraignment of Blackwelder may be shown by calling attention to the several topics which are discussed.

Blackwelder's review is aimed at false science, not against popular science, regarding which he says not a word; yet See uses a column and a half to flay him on that score, and because Blackwelder criticizes Lowell assumes that the criticism is aimed also against the popular work of such men as George Darwin and Proctor.

Blackwelder specifically avoids discussing any astronomic phase of the book, and does not mention the subject of life on Mars. Yet See takes up a column in arguing this matter,

and states: "Of course there is life on Mars; there is no doubt about it."

Lowell has been fortunate in being able to personally build and maintain an observatory, which has been the means of advancing the science of astronomy in a number of lines. See asks what Blackwelder has done in comparison. This question implies that only those whose personal fortunes have enabled them to do what Lowell has done should criticize his work, since those familiar with the scientific results of both will hardly see cause on such lines for invidious comparison.

Blackwelder casually mentions, to the extent of one sentence, "Lowell's implicit belief in the Laplacian hypothesis which now, to say the least, is on the defensive," a remark which calls forth a column from See embracing such statements as, "If Professor Blackwelder will study my own (See's) paper carefully, and the work now in press (by See) when it appears, he will find that most of the recent speculations on cosmogony are not worth the paper they are written on."

See further states that he has proved in four memoirs "that the oceans are gradually drying up and the land increasing, as Lowell maintains. Therefore Lowell is right and Blackwelder wrong; and that too in a subject which he represents as his own." This statement is highly amusing, to say the least, to those cognizant of recent work on paleogeography, especially if they have also read See's voluminous publications on mountain building and related subjects, and noted that they center about the old hypothesis of a free downward permeation of ocean water. A hypothesis which is not open to direct proof, and though still advocated by certain physicists and geologists is distinctly relegated to a subordinate rôle by many economic geologists and such leaders in the more philosophic side of the earth-science as Suess, Chamberlin and Van Hise; partly because of the theoretical difficulties attending an effective downward diffusion of ocean water through the zone of rock flowage, but much more because of the failure of the hypothesis to account for many of the facts now known to geologists. These point rather to a directly opposite view, which is well expressed by the words of Suess, "volcanoes are not fed by infiltration from the sea, but the waters of the sea are increased by every eruption."

The voluminous nature of See's writings on the subject is due to a dressing out of this old and, to say the least, doubtful hypothesis with many speculative additions, with much repetition of well-known facts and theories, and with specific applications in such frequent obvious discord with modern teaching of the principles of physiography and known details of geologic structure and history, that no geologist has felt called upon to comment. In the words of See, "geologists have discreetly kept silent."

On every topic See cites his own work as the authoritative utterances on the subject, and in the last paragraph denounces, as the worst evil of American science, "this clique and faction business, by which a man who is not in the ring never can get justice or fair consideration." Since no group of geologists or, so far as the writer is aware, no single geologist of recognized standing has followed and promulgated the special views in the teachings of See and Lowell, this clique and faction evidently includes the several hundred working geologists of America. To those who are familiar with the situation, this gives the key to the whole of See's article on "Fair Play and Toleration in Science." It is a vicarious castigation in which Blackwelder stands to receive the blows for a host of unnamed men of science, because they have not accepted See's memoirs at the valuation which he places upon them. Is vicarious atonement "fair play and toleration in science"?

Joseph Barrell

New Haven, Conn.,
June 15, 1909

DETERMINATION OF THE COEFFICIENT OF CORRELATION

To the Editor of Science: I should like to make a few remarks on Dr. Franz Boas's letter on this subject in your issue of May 21. There is some danger, I think, unless we see

how new values for the correlation coefficient are related to old values, in a multitude of formulæ leading to divergent and possibly inconsistent results.

Dr. Boas's first value for r

$$-r=\frac{[(x-y)^2]-\sigma_x^2-\sigma_y^2}{2\sigma_x\sigma_y}$$

is a very old friend indeed and has been widely used in a multiplicity of practical cases. It is one of a general series of formulæ noted by me[1] in 1896, and used in our work on the personal equation[2] in 1902 and on wasps[3] in 1906. Since 1896 it has been frequently referred to, *e. g.*, in the memoir "On Further Methods of Determining Correlation"[4] and *Biometrika*, VI., p. 438, etc. It is quite reliable and often convenient.

Dr. Boas's second formula

$$r=\frac{[(x_1+x_2+\cdots+x_n)]^2}{n(n-1)\sigma_x^2}-\frac{1}{n-1}$$

suffers from the difficulty that in the form in which he gives it, it involves the number in the fraternity, being taken as *constant*, whereas in practise we may often have five in one fraternity and ten in a second. Its chief value is when n is very large as in long series of homotypic characters, or in series other than man when the number of offspring is very great. In such cases the second term $1/(n-1)$ is usually of the order of our probable error and may be neglected and $n-1$ may be taken $=n$, within the same limits. Thus:

$$r=\frac{(\text{S.D. of means of fraternities})^2}{(\text{S.D. of population})^2}.$$

Under this aspect it is easy to extend the formula to cases in which n is not the same for each fraternity. A like formula was used in 1898 for our studies on the inheritance of fecundity of thoroughbred horses.[5] It has been since employed in various homotypic investigations. It must be very carefully distinguished from that for the correlation rates

[1] *Phil. Trans.*, Vol. 187 A, p. 279.

[2] *Phil. Trans.*, Vol. 198 A, p. 243.

[3] *Biometrika*, Vol. V., p. 409.

[4] Dulan & Co., Drapers's Research Memoirs.

[5] *Phil. Trans.*, Vol. 192 A, p. 272.

$$\eta=\frac{\text{S.D. of means of arrays}}{\text{S.D. of population}}$$

where $\eta=r$ for normal correlation.

The *arrays* in the latter formula contain many *fraternities*, and their means have far less variability than that of those of fraternities.

Lastly I come to Dr. Boas's formula

$$r=\frac{p_{1,2}-p_1p_2}{\sqrt{p_1(1-p_1)p_2(1-p_2)}}.$$

If we have a fourfold table represented by

a	b	$a+b$
c	d	$c+d$
$a+c$	$b+d$	N

I find Dr. Boas's r is our old friend

$$r_{hk}=\frac{ad-bc}{\sqrt{(a+b)(c+d)(a+c)(b+d)}},$$

i. e., is the correlation in the deviation of the mean of one variable from its mean value with the deviation of the mean of the second variable from its mean value. It is not a true correlation of the first variable with the second variable. I have discussed v_{hk} at length in memoir of 1900:[6]

It has the advantage of a symmetrical form and a concise physical meaning. It does not, however, become unity when either, but not both b and c vanish, nor does it, unless we multiply it by $\pi/2$ and take its sine, equal the coefficient of correlation when $a=d$ and $b=c$.

Thus it differs in the simplest cases from the true coefficient of correlation, and often differs considerably. In the bulk of cases it does not approach r nearly as closely as the "Q_2" coefficient of association, and its use is liable to be misleading, especially if compared with values of the true coefficient found by other processes.

When there is a measurable quantity grouped in arrays under classes of a non-measurable quantity the right method, I venture to think, is to use the correlation ratio η as defined above. This will be equal to r if the correlation be normal, and if not it has a perfectly definite physical meaning of its own.[7]

[6] *Phil. Trans.*, Vol. 195, pp. 12 and 15 bottom.

[7] "On the General Theory of Skew Correlation, etc.," Drapers's Research Memoirs, p. 10.

I am not able to follow Dr. Boas's deduction of a formula for r in this case, and it does not appear to give the true correlation r of the two variables.

KARL PEARSON

BIOMETRIC LABORATORY,
UNIVERSITY COLLEGE, LONDON,
June 6, 1909

THE DARWIN CELEBRATION AT CAMBRIDGE

TO THE EDITOR OF SCIENCE: I shall be obliged if you will allow me to contradict a statement which has been made in an American newspaper in reference to Professor Haeckel and the Darwin Celebration. The article in question was sent to me by a friend as a cutting and I am unable to give the name of the newspaper. The writer of an article entitled "Haeckel, the fighting scientist retires from Jena University," says: "He (Professor Haeckel) would have been glad to accept an invitation to the Cambridge celebration of the Darwin centenary—had he received it. None came, however, although a large number of such invitations have been sent to scientists who, to say the least, are no more distinguished than himself and to hundreds of scientific societies. It is strongly suspected that clerical prejudice has had a large share in this extraordinary omission. It is quite unjustifiable, for, whatever may be thought of Professor Haeckel's philosophic speculations, not even his enemies venture to deny his great service in the development of Darwinism."

The facts are these: A large number of universities, academies and learned societies were invited by the University of Cambridge to appoint delegates to attend the Darwin Celebration in June of this year. In response to this invitation the University of Jena appointed Professor Haeckel as its delegate. At a later date, after replies had been received from universities and other corporate bodies, several invitations were sent to individuals other than those already nominated as delegates. A short time ago Professor Haeckel wrote to express his regret that ill-health rendered a visit to Cambridge impossible, and his successor in the chair of zoology, Professor Plate, was appointed in his stead. I need hardly add that if Professor Haeckel had not been appointed a delegate he would certainly have been invited as a private guest. I may state that some years since Professor Haeckel received from Cambridge University the honorary degree of doctor of science.

I am, Yours faithfully,

A. C. SEWARD

One of the Honorary Secretaries to the Darwin Celebration Committee; Professor of Botany in the University.

BOTANY SCHOOL,
CAMBRIDGE, ENGLAND

QUOTATIONS

VIVISECTION

LITERARY reference or allusion makes readable sometimes the barer facts of science. The vogue of Rudyard Kipling will render more popular a scientific cause to which he happens to lend his name. It is for that reason, rather than for the value of his statement, that we quote the poet as follows on a question of the day:

> The doctor is exposed to the criticism of persons who consider their own undisciplined emotions more important than mankind's most bitter agonies; who would cripple and limit research for fear research might be accompanied by a little pain and suffering. But if the doctor has the time to study the history of his own profession he will find that such persons have always been against him—ever since the Egyptians erected statues to cats and dogs on the banks of the Nile.

The opponents of vivisection ought to oppose murder, and therefore to be vegetarians. They should also object to forced labor and therefore never ride behind a horse. They should in sound logic oppose larceny and not drink milk. They should never allow an animal to be punished in process of being trained. In scientific experiment few animals are taken, compared to those killed for food or kept at forced labor all their lives. Most of them are unconscious. The question of when to use anesthetics must be left to science, since in a small but important fraction of the work drugs must be dispensed with; and it would be fatal to have ignorant outsiders concerned in so critical a decision. Such outsiders are cap-

able of judging sanely neither about the amount of pain involved nor the importance of the knowledge to be obtained. Says President Eliot of Harvard University:

> The humanity which would prevent human suffering is a deeper and truer humanity than the humanity which would save pain or death to animals.

Moreover, the experiments give knowledge which saves pain not only to millions of human beings, but in many cases to animals themselves. In tuberculosis, for instance, the men of science are fighting for cattle as well as for men; in lockjaw, for horses as well as for our own kind. The marvelous results in diphtheria have happily now become known to almost every mother. To stop animal experimentation would check the advance of surgery. It would take away our strongest weapon in the promising fight being waged against cerebro-spinal meningitis, bubonic plague, dysentery and malaria. It would reduce us to despair in the harder but still hopeful contest with cancer.—*Collier's Weekly*.

SCIENTIFIC BOOKS

The Manufacture of Explosives—Twenty Years' Progress. By Oscar Guttmann. 8vo, 84 pp., 11 illustrations. New York, The Macmillan Company. 1909. Price $1.10 net.

The major title of this book is identical with that of the well-known two-volume work by the same author which was published in 1895. The make-up of the new volume is similar to that of the older ones and it may properly be regarded as a supplement to them. The significance of the subtitle is not apparent on a close reading of the text, for the first installment begins with an historical résumé from 1250 to 1886, and this same method of treatment obtains throughout the book as new topics are introduced. Even taking 1886 as the point of departure, this date precedes the publication of the first volumes by nine years, so that there is necessarily some repetition in the supplement, but much of it is avoided by referring to the descriptions published in the earlier volumes. Nevertheless, this feature should be borne in mind when citing this author in litigation or for historical precedence and the statements of the supplement should be carefully compared with those of the major parts.

This condition has arisen from the fact that the present volume is a record of four Cantor lectures delivered before the Royal Society of Arts in 1908 and that such historical résumés were deemed necessary to properly introduce the topics. Lecture I. deals with black powder and other nitrate mixtures, chlorate mixtures, "metallic" explosives, picric acid, picrates and trinitrotoluol; lecture II. with nitroglycerine, dynamites, guncotton and nitrostarch; lecture III. with smokeless and flameless powders, fulminates, detonators and fuses, safety explosives and their use, particularly in mines; lecture IV. with the use of nitrocellulose in other industries, the construction, lighting and inspection of factories, accidents and precautions to be taken, the merits and demerits of explosives, stability of explosives and stabilizing agents, and finishes with a prophecy regarding the powder of the future.

The author holds a very poor opinion of nitrocellulose as a material from which to make smokeless powder, though all smokeless powders now adopted for military and naval use are composed of nitrocellulose alone or mixed with nitroglycerine, and he predicts that a stable nitro-compound of the aromatic series alone, or in conjunction with nitroglycerine, will come into use so soon as some government finds the courage to make the change. He likewise regards picric acid, which has been adopted by almost every country as a disruptive agent, under names such as melinite, lyddite, shimose powder, ecrasit and others, as a treacherous substance and expresses the hope that we shall some day give up its use.

Considering the use of explosives in mines, he points out the difficulty of determining what makes an explosive safe in fire damp. Thus since mercuric fulminate ordinarily does not ignite fire damp, while black powder does the Prussian Commission state that the more rapid the explosion the safer the explosive, yet certain black powder mixtures like bob-

binite are safe up to a certain point while nitroglycerine and blasting gelatine are not. The French Commission decided that an explosive whose temperature of explosion, as calculated by certain thermochemical data, was below 1,500° C., could be licensed for use in fiery mines, yet carbonite, which is one of the safest of all, and several others in use, have a temperature of explosion considerably above 1,500° C. Bichel and Mettegang, whose investigations in this field are highly praised, require slow detonation as one of the characteristics of a safe explosive, yet "the velocity of detonation can not, however, be considered to be a determining factor under all circumstances. Certain nitroglycerine explosives, amongst which we may also include carbonite, explode much more rapidly than, say bobbinite, and yet show themselves to be much safer when tested." Even in making firing tests in galleries, as is now being done by several governments and organizations, the author finds that the results differ with the shape and dimensions of the galleries, so that each gallery may have its own ignition temperature which would affect the results obtained.

In discussing this topic the author says: "It has been known for a long time that coal dust as well as pit gas is highly explosive," while he knows perfectly well that neither coal dust nor pit gas is explosive by itself, though they may form explosive mixtures with the air. Also in discussing "smokeless," "flameless" and "safety" explosives he fails to point out that these terms are used in the art in a purely relative sense and that an explosive possessing these purely negative qualities absolutely does not exist. Justice requires us to state, however, that when discussing catastrophes in explosive works he says: "The author has always warned manufacturers and users alike that the function of an explosive is to explode, and that although certain compositions are almost insensitive to ordinary impulses, such as blows, friction, etc., yet he never believed that any explosive existed which under favorable conditions and by proper means could not be made to explode," but this point is emphasized because in a publication such as this, which may be cited as authority in litigation in which important interests are involved, care should be taken that no loose terms or unqualified phrases regarding the properties of matter are used.

Surprise is expressed at the extent to which black powder is still being used, it being stated that 7,000 tons of it were used in the mines and quarries of Great Britain, and 3,597 tons exported in 1907, making 10,597 tons in all. This is markedly less than the output of the United States, where the production of black powder at the census of 1900 was 62,412 short tons and at that of 1905 was 107,910 short tons. In fact, since the statistics of this industry in the United States were first separately taken, at the census of 1840 there has been a constant increase at each decade, and this failure of "smokeless" powder to supplant black powder was commented on with fullness in the Census Bulletin for 1900.

The book is filled with information, much of which is quite up to date, and it bristles with references, a large part of which are to British patents. A defect is in its limited use of American sources, patent or other readily accessible literature, for a country which produced 363,748,097 pounds of explosives of all kinds in the census year 1905 can not have failed to have made useful contributions to the progress of the art. Nevertheless, the book is a good one. It is more than a compilation, for it is thoughtful, critical and sometimes controversial. Every one of the many who possess the parent volumes must also acquire this and they will be pleased to have done so.

CHARLES E. MUNROE

Birds of the World. By FRANK H. KNOWLTON, Ph.D., with a Chapter on the Anatomy of Birds by FREDERIC A. LUCAS. The whole edited by ROBERT RIDGWAY. With 16 colored plates and 236 other illustrations. American Nature Series, Group 1, Natural History, pp. i–xiv, 1–874. New York, Henry Holt & Co. 1909.

In the elaborate and excellent American Nature Series, now in course of publication, Knowlton's "Birds of the World" forms the third issue under the head of "Natural History," having been preceded by Jordan's "Fishes" and Kellogg's "American Insects."

Writers of bird-books sometimes hear the remark in tones of disparagement: "But you describe so few birds! The robin and the chipping sparrow are very well in their way, but we should like to read about the bird-of-paradise, and the toucan as well." Such critics will have no case when they handle Mr. Knowlton's weighty volume, for in this treatise he reviews the entire class; there are over eight hundred large pages, and these are embellished with nearly two hundred and fifty illustrations.

When we reflect that the birds of the world comprise upwards of twelve thousand species, and that the major and minor celebrities form a great company, with an already vast and ever-growing literature, the labor and difficulty of preparing a well-balanced hand-book for the entire field, which shall be both useful and interesting, is a task of no holiday order. In our opinion the author has succeeded admirably in nearly every respect. His work, from necessity a compilation, is certain to prove very useful; it is published in attractive form, and possesses a large fund of interesting facts concerning the structure, classification and general habits of the better known and more important members of the entire avian group.

The body of the work is preceded by several sections of an introductory nature, dealing with the general characteristics of birds, with their distribution, migration and zoological relations. This part further includes a very compact and valuable chapter on the Anatomy of Birds by Mr. Frederic A. Lucas. The fact that the entire work has passed under the "editorial censorship" of Mr. Robert Ridgway should tend to discourage those critics whose appetite is whetted by their ability to find mistakes. Twenty-one chapters follow on the "orders" in the classification adopted by the author, beginning with the sole occupant of a subclass, the famous *Archæopteryx,* which has been pronounced three fourths "bird" and one fourth "reptile," and ending with the great order of Passeriformes, said to embrace over seven thousand species, or more than one half of all known birds. This is followed by a full, and therefore useful index.

Dr. Knowlton's book is presumably not one of the kind intended to be read from cover to cover, but like Newton's "Dictionary of Birds" and other extended treatises, is to be used as a compendium for reference. The author has surveyed the most pertinent literature so well, and has preserved so sane a judgment in dealing with it, that he is a guide to be trusted on all matters of which he treats. His errors will be found to be chiefly those of omission.

Some criticism could be made of the author's style, but this is certainly even and clear, and probably well adapted for a reference-work of this kind. The reviewer has found no errors of consequence, those noted being of a rather trivial order, as when in speaking of the night-hawk, Mr. Knowlton says (p. 43): "Some individuals" spend "the summer in Alaska and the winter in Patagonia," which may be true, but is an assumption, to be tested only by the marking of individual birds. The "banding" or "ringing" of individuals to obtain exact data on migration, first tried with a measure of success on the *Phœbe* by Audubon, has been taken up rather recently, and with the promise of yielding very valuable results.

We miss from the introductory matter any summary of the modern work on the instincts, intelligence or general behavior of birds, a subject no longer of interest to psychologists only. In speaking of the absence of "hook-like processes of the ribs" in *Archæopteryx* as a "decidedly reptilian character" it should perhaps be noted that the New Zealand lizard-like *Hatteria* possesses them, as well as the crocodile and alligator, and the latter, moreover, builds a nest which is guarded by the male.

We can not subscribe to the view that "we are without an adequate theory of birds'

nests," for we regard the nesting instinct as no more inexplicable than the other instinctive actions which recur with almost clock-like regularity in the reproductive cycle of most birds. The entire round of activities which leads to the production of a certain type of nest, as in the robin, vireo, or oriole, is without doubt remarkably uniform and stable. But it is far less stable or uniform than the conditions which determine the form and color of the egg. If this is true it is not altogether surprising to find some open nests with snow-white eggs, and some closed ones, like the magpies', in which the eggs are spotted. Yet no one could maintain that the behavior of the wild bird is to be explained by any simple formulæ, at any point.

The abundant illustrations which have been drawn from a variety of sources, are naturally uneven in proportion and quality, half-tones of photographs from life having been excluded to keep down the weight, but the plan thus followed has certainly led to variety in abundant measure. FRANCIS H. HERRICK

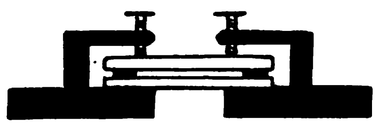
SPECIAL ARTICLES

A SIMPLE FABRY AND PEROT INTERFEROMETER

DURING a course of experiments with interferometers it was found that a very simple and inexpensive Fabry and Perot instrument could be constructed of plate glass which gives results almost as good as the costly interferometer. The construction of this apparatus for demonstration purposes will well repay the teacher and student. The sharp-colored interference rings obtained by using luminous gases in vacuum tubes as sources are extremely beautiful. The D lines from a sodium burner are easily separable. If the interference pattern using a copper or iron arc is focused on a wide slit of a single prism spectrometer, a section of the interference rings is seen in the various spectrum lines, illustrating the method of Fabry and Buisson for the determination of the new standard table of wave-lengths. The Zeeman effect can also be easily shown with this apparatus.

Take two pieces of plate glass about an inch square (I have used the so-called German plate) and silver[1] them till one surface of each plate cuts down the intensity of the transmitted light to about a quarter of the incident light. Separate these silvered surfaces by two strips of cardboard. A useful thickness to begin with is the cover of the 24 two-cent postage-stamp book, as this will clearly separate the D lines. Mount these plates over a half-inch hole in a metal plate by means of three pressure screws, two of which are shown in the following diagram, being a section through the center. The third screw is midway between the other two and at the end of the plates.

Looking normally through the plates at the glowing filament of an incandescent lamp, a number of images of it will probably at first be seen. Adjust the pressure screws until these images are in juxtaposition in the line of sight; the silvered surfaces are then approximately parallel. Place the instrument in a clamp stand, and focus the light from a sodium flame or a vacuum tube upon the plates and look at the interference bands with a small laboratory telescope focused for infinity. Usually the eyepiece has too large a magnification for the above retardation and it is better to use in place of it a single lens



of focal length about two inches. At first only a small section of the interference pattern is seen, but with a little careful adjustment of the pressure screws the whole ring system is obtained in sharp focus. Removing the telescope and with the above lens used as eyepiece, focus the interference system from the above sources or an arc, upon the slit of a spectroscope. The bands in the different spectrum lines are then observed with the telescope on the spectrometer.

For further suggestions regarding the adjustments and other experiments for which this apparatus can be used, refer to an article

[1] For silvering solutions see the appendix to Baly's "Spectroscopy."

by the writer in the *Philosophical Magazine* for May, 1904.

JAMES BARNES

BRYN MAWR COLLEGE

SOME COMMENTS ON THE REACTIONS OF PERICHÆTA

IN a discussion of the method of trial in SCIENCE, Vol. XXVI., 662, Professor H. B. Torrey referred to the writer's description of the light reactions of *Perichæta*. He interpreted the behavior of *Perichæta* in weak light as displaying "Unterschiedsempfindlichkeit" and not the tropic reaction, with the resulting conclusion that there would be no orientation in weak light. The writer had stated that *Perichæta* responds to weak light chiefly when the anterior end is extended, presumably because of the greater exposure of photoreceptor cells in the integument. Torrey called these "Unterschiedsempfindlich" reactions because apparently due to an increase in the intensity of the light on the cells. Loeb first introduced the distinction between the tropism as a constant stimulus effect and the reaction to change of intensity in the case of *Serpula*, which bends towards the light and also withdraws suddenly into its tube from the stimulus of a shadow cast upon the oral end. Except for the opposite sign of the heliotropism the reactions of *Perichæta* and this other annelid bear a family resemblance. I need only refer to the familiar facts that *Perichæta* or *Lumbricus* turn away from all but the weakest light and retract into their burrows on sudden illumination. In the open, the worm gives the "Unterschiedsempfindlich" reaction of retracting its head on sudden illumination with strong enough light and after a period of backward creeping follows this up by a tropic, turning response effects of sudden illumination are conspicuously wanting in weak light, as ordinarily only turning movements appear.

A form of response to illumination of the anterior end which is between these extremes consists of creeping backward after a distinct pause, which is often prolonged, and without any sudden movements which would naturally be related to the change produced by the stimulus. These weaker responses might naturally be regarded as constant stimulus effects. Reactions attributed to change of intensity ought to give manifest evidence of the shock in resulting movements or inhibitions.

The objection is raised that the transitoriness of the stimuli in weak light, received during extension movements, would preclude their giving rise to orientation. The tropism is ascribed to a differential tonus produced on the muscles of the two sides. There is no apparent reason why even transitory light stimuli of any intensity might not produce some appreciable tonic effects. It appears, however, that a considerable change of intensity is required to temporarily inhibit forward movement, as is the case in retraction of the head. If the sudden manifestations of shrinking are absent in weak light is it not apparent that the threshold for "Unterschiedsempfindlich" effects is higher than for purely tonic, *i. e.*, tropic effects in the earthworm? As for the application of the trial hypothesis to the behavior in weak light, that is only giving a name to the somewhat gradual process of orientation, interrupted by movements contrariward which are less influenced by the light.

E. H. HARPER

NORTHWESTERN UNIVERSITY

ENTOMOLOGICAL CONFERENCE ON THE PACIFIC COAST

THE department of entomology of the University of California has for several years past held four conferences during the school year at stated intervals, the place alternating with Berkeley. Thus during the last school year four such conferences were held, two at Berkeley, one at Watsonville and another at Davis. The last of these meetings, held in Berkeley, was planned to be more inclusive, inasmuch as entomologists from the entire Pacific coast were invited to attend and present papers. The hope was also expressed that a special organization of western entomologists might be effected, inasmuch as the insect problems of the Pacific slope are so different from those on the other side of the Rocky Mountains.

At this meeting, held April 20 to 23, the following general program was carried out:

Tuesday afternoon (April 20), Lime Sulphur, Its Use and Manufacture. Evening, The Manufacture of Miscible Oils and Arsenical Insecticides.

Wednesday morning (April 21), The European Elm Scale, and the Codling Moth. Afternoon, The Orange Scale and the Citrus Mealy Bug. Evening, Exhibits of Insecticide Materials, Insect Collections, Apparatus illustrating Methods of Study, etc.

Thursday morning (April 22), Visit to Oakland Formicary. Afternoon, Forest Insects and Apiculture. Evening, Medical Entomology.

Friday morning (April 23), Methods Used in the Study of Sensory Reactions, Insect Photography. Afternoon, permanent organization.

The meeting was well attended, notwithstanding the enormous distances separating the workers on the Pacific coast. As had been hoped at the outset, a permanent organization was effected under the name Pacific Slope Association of Economic Entomologists. The constitution adopted requires that active membership shall be limited to the official and professional entomologists of the Pacific slope, while associate membership shall be open to agriculturists and to all others interested in the objects of this association. The following officers were elected:

President—Professor C. W. Woodworth, University of California, Berkeley, Cal.

Vice-presidents (representing each state concerned)—Professor R. W. Doane, Palo Alto, Cal.; Professor S. B. Doten, Reno, Nevada; Professor J. Elliott Coit, Phœnix, Arizona; Professor Fabian Garcia, P. O. Agricultural College, New Mexico; Professor E. D. Ball, Logan, Utah; Professor A. B. Cordley, Corvallis, Oregon; Professor A. L. Melander, Pullman, Washington; Professor L. F. Henderson, Moscow, Idaho; Professor C. P. Gillette, Fort Collins, Colorado; Professor R. A. Cooley, Bozeman, Montana; Professor Aven Nelson, Laramie, Wyoming; Hon. Thos. Cunningham, Vancouver, B. C.

Executive Committee—Mr. R. R. Rogers, San Francisco, Cal.; Mr. H. P. Stabler, Yuba City, Cal.; Mr. L. H. Day, Oakland, Cal.

Secretary-Treasurer—Professor W. B. Herms, University of California, Berkeley, Cal.

It is planned to hold the next meeting this summer at Portland, Oregon.

W. B. HERMS,
Secretary-Treasurer

SOCIETIES AND ACADEMIES

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

THE 667th meeting was held on May 22, 1909, Vice-president Wead in the chair. Mr. Edwin Smith read a biographical sketch of Mr. William Eimbeck. Two papers were read.

Investigation of Dip Needle Corrections by Experimental Methods: P. H. DIKE, of the Carnegie Institution of Washington.

The values of the inclination, or dip of the magnetic needle, as observed by the absolute method with the dip circle, in general still require some correction, and the error is not eliminated by multiplying observations as the correction is a constant one for a given station. The correction is found to vary with the dip and the total force, and it is accordingly necessary to take account of this variation in the reduction of the observations made by the various expeditions of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington covering a large range of the magnetic elements. In the *Galilee* work on the Pacific Ocean dip circles were compared with observatory instruments over as wide a range of dip as possible (+ 74° to — 68°), and from the corrections thus obtained empirical formulæ were established by least square methods from which the probable corrections for intermediate values of dip were derived.

The purpose of the present investigation is to derive these corrections by comparison with a single standard instrument (an earth inductor) at one station and through the whole range of positive and negative dip. An artificial field is produced by a system of coils, through which a uniform current from a storage battery flows. Two coaxial coils of 80 cm. radius are mounted with axis vertical, 80 cm. apart, each coil having 100 turns of wire. A second pair 90 cm. in radius and 90 cm. apart are mounted with axis horizontal, the middle points of the axes of the two pairs of coils coinciding. The second pair has 50 turns each of wire. By regulating the currents in the two sets of coils any desired magnetic field can be produced at the center, and this field is extremely uniform over a considerable area. Two systems of coils are set up about 50 feet apart, the horizontal coils of one being in series with those of the other, and the vertical coils likewise in series with each other. Simultaneous observations with earth inductor and dip circle are made

at every 20° of dip from + 80° to — 80°, with interchange of instruments on each dip, to eliminate station difference. Curves were shown representing the corrections thus determined for the four needles of a Dover land dip circle recently purchased, which is found to be an exceptionally good one. The corrections range from + 0′.5 to — 2′.8. The similarity of the curves for the four needles suggests that part of the error is inherent in the dip circle rather than in the needles. The station difference showed a regular variation with the dip, following approximately a sine curve. Possible variations in method and sources of error were discussed.

Ship dip circles in general exhibit a considerably larger variation in the correction with varying dip and force than the land instruments.

The Carnegie Institution Marine Collimating Compass: J. A. Fleming, of the Carnegie Institution of Washington.

The experience gained on board the Magnetic Survey yacht *Galilee* indicated the necessity for developing an instrument of greater precision for determining magnetic declination at sea. The instrument exhibited was devised by Mr. W. J. Peters, who is in charge of the ocean magnetic survey work of the institution.

The compass is of the liquid type. Four spherical mirrors are attached to the buoyant air chamber at intervals of ninety degrees, their optical centers being in the horizontal plane through the point of suspension. In the focus of each mirror there is a scale of thin, blackened German-silver wire. The optical arrangements are such that homocentric rays from the scales are reflected through the dilute alcohol in which the compass is mounted and issue as parallel rays into the air through windows exhibiting the scales each as seven luminous points one degree apart. The windows are segments of spherical shells, the centers of which are at the point of suspension so that the optical conditions are not altered by the rocking of the bowl and other motions at sea. The bowl swings in a perforated gimbal ring supported in a spindle-bearing cylinder with graduated base, thus making it possible to quickly orientate the optical systems. The usual form of binnacle stand with suitable alterations is used.

The method of observation calls for the measurement of the angle, a, between the collimator and a celestial body of known altitude, h. As the angle, c, between the zenith and the collimator is ninety degrees, the fundamental formula takes the form $\cos A = \cos a \cdot \sec h$ where A is the magnetic azimuth of the celestial body. (For small values of A more accurate results may be obtained by use of formula involving the tangents of half the sum and difference of a and h.) Errors in c due to rocking may be eliminated by suitable arrangement of a series of observations. Lack of perfect adjustment of collimator producing error in c of dc which may be easily measured and the resulting error in A corrected by $dA = -\cot B \cdot dc$, where B is the angle between the vertical plane and the great circle passing through the collimator and the celestial body. Owing to the trigonometrical relations involved, the conditions are not good for values of a less than 45° or more than 135° for the usual upper limit of altitude of 15°; it is for this reason that four collimators are used, as then suitable selection may be made.

A special instrument for measuring the angle a has been constructed, although the usual form of pocket sextant may be used for this purpose. This instrument, which may be called a circle of reflection, makes use of the law that the incident and reflected rays lie in the same plane normal to the mirror surface; the construction is such that the angular motion of the mirror is equal to the angle measured.

The advantages are: motion is practically restricted to the oscillation of the magnets; the celestial body observed upon and compass scale are seen simultaneously and all the observed quantities refer to the instant of observation; there are no movable parts subject to wear; graduation errors are limited to twenty-eight divisions, a number so small that each may be separately examined; error of eccentricity affects only the distance between mirror and corresponding window, hence the focal distance and consequently the scale values, but does not alter the constant for the middle of each scale. By the attachment of a suitable standard centrally to the bottom of the bowl horizontal intensity determinations by the method of deflections introduced by Dr. L. A. Bauer can be made and from the same measures accurate values of declinations may be derived.

The instrument is not intended for navigational purposes, but it is hoped that it may give much greater precision in the determination of declination at sea for use in the more careful study of the laws governing the distribution of magnetism over the globe.

R. L. Faris,
Secretary

SCIENCE

FRIDAY, JULY 9, 1909

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

A REVIEW OF CURRENT IDEAS ON THE TEACHING OF MATHEMATICS[1]

THE subject of elementary mathematics has been the last to respond to improved pedagogical methods. Recently, however, there has been a general awakening of interest in methods of mathematical instruction which seems to be universal in its scope, and to have originated simultaneously in France, Germany, England and the United States. Although the discussions have been widely varied, there is practical unanimity on the point that mathematical instruction should be less formal and more practical, and should constitute simply an extension of the ordinary experience of the child.

Although the ideas recently expressed are almost wholly deductions from experience, they seem, for the most part, to have a scientific basis. They recognize, namely, that the child learns as the race has learned, by proceeding from concrete and familiar facts to the general laws underlying all

[1] A summary of reports on special topics, assigned in connection with a course for teachers on the history and teaching of mathematics, given by Professor S. E. Slocum at the University of Cincinnati, 1907–8. The class, part of whose work is here presented, was composed as follows: Charles Otterman, A.B., professor of mathematics, Woodward High School, Cincinnati, Ohio; Albert Schwartz, A.B., principal Linwood School and principal East Night High School, Cincinnati, Ohio; Benjamin H. Siehl, A.B., teacher eighth grade, Morgan School, Cincinnati, Ohio; Charles H. Siehl, A.B., teacher eighth grade, Garfield School, Cincinnati, Ohio; Jesse K. Dunn, principal Highlands School, Cincinnati, Ohio; F. L. Williams, A.M., principal William Grant High School, Covington, Kentucky; Howard Hollenbach, B.Sc., instructor in science, Lockland High School, Lockland, Ohio.

experience. The historical parallel, in fact, is strikingly manifest in the form, content and sequence of development of elementary mathematics as proposed in these reforms.

GERMAN REFORMS[2]

The nineteenth century may be divided into three periods as regards the form and content of mathematical instruction in Germany. In the first period, extending from 1800 to 1870, mathematical instruction was a mixture of the pure and applied. Ideals were high, efforts were directed toward awakening individual ability, and attempts were made to teach more than is required at present. The candidate for the position of teacher of mathematics must be a specialist capable of original investigation, and as a result we find such names as Grassmann, Kummer, Plucker, Weierstrass and Schellbach.

The opening of the second period, 1870–1890, was signalized by the victory over France, and the assumption by Germany of a more important international position. This period was marked by a separation of pure and applied mathematics. In the schools the feeling prevailed that the development of the especially gifted pupil was not to be sought so much as that of the average pupil, and consequently greater interest was manifested in the method of instruction. Instead of the early system, a desire was expressed for a systematic graded course in mathematics, keeping in view the ability of the constantly developing pupil. Drawings and models were demanded, problems were so stated and aids so given that the pupil might see space relations and not depend so largely on the logic of the ancient Greeks. This was a direct result of the teachings of Pestalozzi and Herbart. In this period the standard for teachers was lowered, and there was only required a knowledge sufficient to solve problems of moderate difficulty.

The third period, beginning with 1890, seems to be characterized by a tendency to again associate pure and applied mathematics. That is to say, a teacher is required to be thoroughly familiar with pure mathematics and at the same time to have an extensive knowledge of its applications.

For many decades the value of mathematical training was thought to lie in its formal discipline. Before the revival of learning it was the utilitarian factor which was emphasized, while in the last few decades the majority have reached a more comprehensive notion. Recently Professor Felix Klein, the greatest of living German mathematicians, has shown a deep interest in the problems of the schools, and has taken an active part in their discussion. His views are typical of modern German scholarship, and form the basis of the reforms instituted and proposed.[3]

According to Professor Klein, mathematical thought should be cherished in the schools in its fullest independence, its content being regulated in a measure by the other problems of the school; in other words, its content should be such as to establish the liveliest possible connection with the various parts of the general culture which is typical of the school in question. Here, then, it is not a question of the method of teaching, but rather of the selection of material from the great mass furnished by elementary mathematics.

Much of the material of instruction, although interesting in itself, lacks connection and is wholly or partially isolated, thus affording only a faulty and indirect

[2] For a more detailed account, see article by Charles Otterman entitled "A Review of Klein's Attitude on the Teaching of Mathematics," SCIENCE, September 13, 1908.

[3] "Neue Beiträge zur Frage des Mathematischen und Physikalischen Unterrichts an den Hoheren Schulen," Klein und Riecke, Teubner, 1904.

preparation for a clear understanding of the mathematical element of modern culture. This element clearly rests on the idea of function, both geometrical and analytical, and this idea should be made the center of mathematical instruction. In fact, Klein's chief thesis is that beginning with the Untersecunda and continuing in regular methodical steps, the geometrical conception of a function should permeate all mathematical instruction. In this is included the consideration of analytic geometry and the elements of differential and integral calculus.

The ground to be covered depends largely upon the ideal of the school. While the formal side must not be overlooked, and a thorough knowledge of the processes must be obtained, the principal aim should be to give a clear conception of the fundamental ideas and their meaning.

Mathematical instruction on the level at which it is carried on in the upper classes of the higher schools has existed in Germany since about the beginning of the eighteenth century. In this early formative period calculus was not considered elementary, for it was the possession of only a few investigators of the highest type. Cauchy's great work on differential and integral calculus appeared in 1821, but the schools had already been led into certain channels, and it was not possible to divert them toward a subject which was only in the process of formation. In fact, calculus was considered as a sort of witchcraft, and has ever since been regarded with suspicion.

The official course of study of 1900, however, showed a tendency in the opposite direction, so that Klein believes that advantage should be taken of this favorable attitude to place that which has taken centuries for preparation upon a generally recognized basis.

As a matter of fact, the ideas underlying the calculus are actually taught in many schools. In a few Ober Real schools they are regularly taught as calculus, but in the majority of schools they are taught in the most round-about manner. In fact, students are actually taught to differentiate and integrate as soon as occasion for the same arises, but the terms differential and integral are avoided.

Klein's opinion is that instead of making instruction in calculus in those grades whose work demands its employment incidental, desultory and generally unsatisfactory, it should be made the central idea of instruction, and the other ideas and work grouped around it. At present, calculus is made the beginning of higher mathematics and is accompanied by a revolution in thinking. Klein's suggestions aim to obviate this difficulty by gradually accustoming the pupil to those methods of thinking which later predominate.

THE PRUSSIAN SYSTEM

The Prussian schools are probably the most efficient, in point of actual instruction, of the entire German school system, and for this reason deserve special consideration.

Although but 1.2 years of the nine school years are given to mathematics as compared with 2.1 years in this country, the Prussians accomplish fully as much as, if not more than, our American schools, with a saving of .9 of a year, or .1 of the total time of instruction for the nine years.

The three main causes of the excellence of the Prussian work in mathematics are the central legislation and supervision, the thorough preparation of the teachers and the systematic methods of instruction. Each of these is a result of the preceding; for well-prepared teachers are likely to use good methods of instruction and the thorough preparation of teachers is sure to be

required when the legislative and executive authority is vested in experienced educators of the highest order. It might be sufficient to say that the strength of the Prussian system is due to the fact that for two thirds of a century the work has been centered in a single source of authority for the entire kingdom.

In American schools considerable loss is due to the fact that during the nine years which correspond to the German Gymnasium, every pupil must make two changes, viz., from the grades to the high school and thence to college. The work of these nine years is thus carried on under different circumstances, with different names and methods, and under teachers differing in their preparation; and instruction necessarily suffers in consequence.

The Germans appreciate the fact that the teacher can do his best only in an atmosphere of financial and mental tranquility, and while insisting on high standards and severe tests at the outset, assure a tranquil career to those who have given evidence of their fitness, by a regular system of promotions and pensions.

In the common schools, the aim is to train good and faithful citizens, the process being called "Erziehung" (bringing up).

In the higher schools, the aim is to impart learning, and to turn out educated and cultured men. The process is called "Unterricht" (instruction), and leads to privileges and responsibilities before the civil and military law. Attendance upon the common schools is regarded as the duty of those not having better opportunities and is enforced by the state, whereas attendance upon a higher school is considered a privilege and the state may restrict the number of persons admitted.

The work in mathematics done in the higher schools covers practically the same ground as our course to the close of the freshman year in college. The general aim of the instruction is facility of calculation with numerical quantities and their application to the usual circumstances of everyday life, algebra to quadratics, plane and solid geometry, plane trigonometry, the idea of coordinates and some of the fundamental properties of conic sections. In all of these subjects an effort is made to impart an intelligent knowledge of the theorems, as well as skill and facility in their application.

The entire mathematical education of the boy from the elements of arithmetic to those of analytic geometry takes place in one institution under one management guided by the close supervision of the same director and under the tuition of men of the same scientific training, who are colleagues, working in close contact, with opportunities for intimate interchange of ideas.

The aim of the teaching of arithmetic is to secure facility in operations with numbers. In order that it may be in harmony with the following algebraic instruction, and prepare for it, the reviews of the fundamental operations and the treatment of fractions is based upon mathematical form, and the handling of parentheses is continually practised. In fractions the pupil is taught to operate with fractional parts as concrete things, and facility in computation is maintained by continued numerical exercises in the algebraic instruction in the following classes.[4]

In the Real Gymnasium the scope of instruction in algebra includes the proof of the binomial theorem, and the solution of equations of the third degree; plane geometry, including the theory of harmonic points and pencils and axes of symmetry;

[4] For a description of courses see "The Teaching of Mathematics in the Higher Schools of Prussia," J. W. A. Young, Longmans, 1900.

solid geometry, and the elements of descriptive geometry; plane and spherical trigonometry; introduction to the theory of maxima and minima; plane analytic geometry.

In addition to this the Oberrealschule requires the most important parts of algebraic analysis. Equations of the fourth degree, and the approximate numerical solution of algebraic and transcendental equations may be taken up at the option of the instructor. In all these topics the aim is to give practise in the application of the theorems, as well as to lead to a mastery of the proofs. Considerable stress is also laid upon the oral solution of easy exercises.

The German higher school system speaks with no uncertain tone of the practical advantage of beginning both algebra and geometry early; and continuing their study simultaneously through a number of years.

The method of instruction in Prussia may be styled the genetic method in that it does not require any previous preparation of the pupil for the work of the hour. The quantity of home work is kept as small as possible, and material that has not been thoroughly explained in the class is never assigned to be studied privately by the pupil. A text-book is officially required but is seldom used, and at most the pupil is only referred to it after class treatment, and not before. The genetic method has been but little used in America, but there is a strong trend toward the use of the heuristic method, which is somewhat similar. It resembles the genetic method in its marked effort to keep the pupil thinking for himself, but differs from it in that the class is the working unit in the genetic method, whereas the pupil is the unit in the heuristic method. This difference may be said to be characteristic of the German and American methods of mathematical instruction. In Germany the class works as a whole under the guidance of an instructor. In America the individual pupil demonstrates, explains and asks and answers questions, while the others listen to him.

While the results of the genetic system as applied to the Prussian schools amply justify its use with German pupils, it by no means follows that the method is of universal application, and could be used to advantage in this or other countries. The other features of the German school system, however, relating to the high standard of technical excellence in the teaching profession, and the correlation and continuity of instruction, are of the deepest and most general pedagogical significance.

ENGLISH REFORMS: THE PERRY MOVEMENT

The English reforms are largely based on the so-called "Perry movement," which originated from a paper on the teaching of mathematics read by Professor John Perry at a meeting of the British Association in Glasgow in 1901.[5] In this paper Professor Perry maintained that *usefulness* should be the criterion for determining what subjects should be taught to children, and in what way they should be taught.

The present methods of teaching mathematics keep students so long upon the knowledge already organized that there is neither time nor enthusiasm for undiscovered fields. Absolute correctness and philosophical insight receive too much attention in the teaching of elementary subjects. For example: the first four books of Euclid might be assumed, or accepted partly by faith and partly by trial, and the sixth book regarded as axiomatic. In this way the student might begin his work earlier and much more be accomplished. What is

[5] "Discussion on the Teaching of Mathematics," edited by Professor Perry. British Association Meeting, Glasgow, 1901. Macmillan, 1902.

omitted would be compensated for by an increase in youthful enthusiasm and the development of individuality and inventiveness.

It is well recognized that the study of natural science is essential to all courses of study. Such study, however, is impossible without a practical, working knowledge of mathematics, and facility in its application to problems in engineering and general science. The elementary study of nature requires skill in computing with logarithms; knowledge of, and power to manipulate, algebraic formulas; the use of squared paper, and the methods of the calculus. Professor Perry believes that boys may not only become skilful in the use of these instruments, but will learn them with pleasure. He also asserts that the men who are teaching orthodox mathematics are not only destroying what power to think exists, but are also producing a dislike and hatred for all kinds of computations, and, therefore, for all scientific studies of nature.

As the basis of his belief that instruction in elementary mathematics should be made more practical, Professor Perry states that

> In the whole history of the world there was never a race with less liking for abstract reasoning than the Anglo-Saxon. Every other race has perfected abstract schemes of government. Here common-sense and compromise are believed in; logical deductions from philosophical principles are looked upon with suspicion not only by legislators but by all our most learned professional men.

All of this indicates that philosophy is certainly not intended for children. This was also the view of the ancient Greeks, who held that only a few men were capable of philosophic insight. Reading, writing and ciphering were at one time regarded as learned studies. However, when they became essential to the correct doing of one's daily work, they were taught quite readily to children without unnecessary philosophy. So the child should learn mathematics without unnecessary philosophy. Omitting this philosophic insight, the average boy may learn much useful mathematics which will serve him all through his life.

Professor Perry's plan lays emphasis upon the following propositions: (1) Experimental methods in mensuration and geometry ought to precede demonstrative geometry, although even in the earliest stages some demonstrative reasoning may be introduced. (2) The experimental methods adopted may be left largely to the teacher. (3) Decimals ought to be used in arithmetic from the beginning. (4) The numerical solution of complex mathematical expressions may be taken up almost as a part of arithmetic, or the beginning of algebra, as it is useful in familiarizing pupils with the meaning of mathematical symbols. (5) Logarithms should immediately follow the theory of exponents. (6) The study of the calculus may precede advanced algebra, advanced trigonometry, or analytical geometry, and may be illustrated by any quantitative study in which the pupil may be engaged.

The course in elementary mathematics suggested by Professor Perry includes the following:

In arithmetic, the use of decimals from the outset; contracted and approximate methods, and rough checks on numerical calculation; the meaning and use of logarithms, including the construction and use of the slide rule; calculation of numerical value from algebraic formulas; extraction of square roots; simplification of fractions; calculation of percentage, interest, discount, etc.

In algebra, the translation of verbal statements into algebraic language; numerical application of formulas; rule of in-

dices; factoring, and practise in general algebraic manipulation.

In mensuration, experimental testing of the rules for lengths of curves, for example, in the case of a circle, by rolling a disk, or by wrapping a string around a cylinder; verification of propositions in Euclid relating to areas by the use of squared paper, by means of a planimeter, by using Simpson's or other approximate rules, or by cutting the area out of cardboard and comparing its weight with that of a piece of known area;[6] rules for volumes of solids verified by their displacement of a liquid.

The experimental work in this subject ought to be taken up in connection with practise in weighing and measuring generally, finding specific gravities, illustrating the principle of Archimedes, determining the displacement of floating bodies, and other elementary scientific work. Good judgment will indicate the relative amount of experimental, didactic and numerical work.

The use of squared paper is especially emphasized. Some of its applications which are mentioned, are the plotting of statistics of general or special interest; study of the curves or lines so obtained, such as the determination of their maximum and minimum points, their rates of increase or decrease, etc.; interpolation, or the finding of intermediate values; probable errors of observation and the correction of same; determination of areas and volumes, as mentioned above; plotting of functions and the graphical solution of equations; determination of the laws between observed quantities.

In geometry, the experimental illustration of important propositions in Euclid, frequently supplemented by demonstration; measurement of angles by means of a protractor; definitions of trigonometric functions and the use of trigonometric tables; solution of right-angled triangles graphically and by calculation; construction of triangles and the experimental determination of their areas; method of locating a point in a plane and in space; the elements of descriptive geometry and vector analysis.

The advanced course proposed consists chiefly in an extension and elaboration of the elementary course. It includes demonstrative geometry, and rules in arithmetic and mensuration stated as algebraic formulas. In trigonometry, the study of special limits such as $\sin x/x$ and the derivation of the fundamental formulas and relations of trigonometry. In mensuration, the method of determining the constants in such physical formulas as $pv^n = c$. The course then proceeds to differential and integral calculus and their practical applications; differential equations illustrated by practical problems from mechanics and physics, descriptive geometry and vector analysis.

The reforms proposed by Professor Perry were widely discussed, and were, in general, favorably received. It was not to be expected, however, that the traditional teaching of Euclid in Great Britain would undergo any immediate or radical change, or, in fact, that any innovation of the kind proposed meet at the outset with a cordial reception.

In America, however, Professor Perry's views found ready acceptance and were carried more or less completely into effect. The result was what is now called the laboratory method of instruction which has been developed independently at several places, although along most radical lines at the University High School, Chicago. An outline of the laboratory system, together with a number of typical opinions

[6] This is the way in which Galileo is said to have determined the area of the cycloid.

as to its value and practicability, are given in what follows.

THE LABORATORY METHOD

The works of Klein and Perry mark the beginning of a movement to improve on present methods and make a more direct and pleasant path for the average student in the field of mathematics. The essence of the laboratory method consists in the performing of the bulk, if not all, of the work in the mathematical class room, which should be equipped with laboratory appliances for the graphic, the experimental and the concrete phases of the work. The teacher acts as the director of the laboratory, the pupils work individually or in small groups, and analogies with the work in the physical laboratory are emphasized.

The word *laboratory* undoubtedly came to be used largely from the suggestions received from analogous work in the physics laboratory. In 1886 Safford in his "Mathematical Teaching" said that a mathematical laboratory, although not often mentioned, was a necessity, and should contain such things as relate to ordinary, not purely scientific, measures.[7] Young calls attention to the fact that in the physics laboratory students work singly or in small groups under the general supervision of the instructor, but with direct contact with him for only a few minutes, and that this is a *limitation* of the physical laboratory, and not an advantage.[8]

The advantage of the class recitation over individual or private instruction has been pointed out by W. T. Harris, U. S. Commissioner of Education.[9] The class is the most potent of all instruments in the teacher's hand. He so manages the recitation or class exercise that each pupil learns to see the lesson through the minds of all his fellows, and likewise learns to criticize the imperfect statements made by them through the more adequate comprehension of the teacher. But because in mathematics the instruments are so simple, the benefit of laboratory work may be obtained under *class* direction, thus getting the good features of the laboratory system while avoiding its defects.

The procedure which physicists find best pedagogically suggests a plan for mathematics; namely, not that the mathematical class exercise be supplanted by a mathematical laboratory exercise, but that it be supplemented thereby. The mathematical class exercise should be conducted by some good method as at present, with the usual time allotment. This should then be supplemented by work in a well-equipped mathematical laboratory, either under the direction of the teacher or one or more assistants or both. The pupils should do substantially the same work in the laboratory, and the class exercise should prepare directly for it.

The feeling that mathematics must be made more concrete and must come into closer touch with the realities about the pupil, is growing in Germany, France, England and America; and the influence of the work of Perry can be distinctly marked in the current thought on the European continent.[10]

Professor Moore has defined pure mathematics as a language for the convenient expression and investigation of the most diverse relations of life and nature. The principles of the language are not arbitrary, but are imposed by the phenomena demanding expression.[11] From this it fol-

[7] "Mathematical Teaching," Safford, 1886, Heath & Co., 1896.

[8] "The Teaching of Mathematics," J. W. A. Young, Longmans, 1907.

[9] W. T. Harris, 1897.

[10] "Teaching of Mathematics," Young.

[11] "Cross Section Paper as a Mathematical Instrument," Moore, *School Science and Mathematics*, June, 1906.

lows that mathematics should not be presented ready made. The individual should make his own as the race has done; but not as if the race had never done it. That which is distinctly utilitarian in the course must be thoroughly practical and in accord with modern usage.

This idea has been amplified by Professor W. E. Story, who has pointed out that the education of the individual differs from the life history of the race in that the pupil is made to pass through the essential stages of development without wasting his time on what the experience of former generations has shown to be unessential. In other words, education is selective history, and whatever mode of selection most thoroughly excludes the unessential is most economical, enables the pupil to master the largest amount of what is essential, and gives him most time to devote to exploration of new fields when he has explored the old; that is, leads most rapidly to independent thought, which is the true goal of education.[12]

In America the term *laboratory method* has been coined to name the teaching of elementary mathematics as it would be if remodeled in accordance with the aims and ideals of the Perry movement. The dominating thought is a fuller consideration of the child mind; a sacrifice of the logical to the psychological, or rather a recognition that no method of instruction is truly logical which is not psychological. The keynote is interest, viz., that mathematics must be presented to the child in the most interesting way.[13]

One of the most significant features of this movement is its insistent demand for a closer correlation of subjects; or, more specifically, that mathematics and physics be organized into one coherent whole and no distinction recognized between mathematics and its principal applications. This, as shown in what precedes, is also the trend of ideas in Germany. It is essential that the pupil should be familiar, by way of experiment, illustration, measurement and every other possible means, with the ideas to which he applies his logic; and, moreover, should be thoroughly *interested* in the subject studied.[14]

Following out this idea, the secondary schools should advance independently of the primary ones, and algebra, geometry and physics, including astronomy and mathematical and physical geography, be organized into a four years' course comparable in strength and closeness of structure with the four years' course in Latin. The physics should be practical, and selected by an engineer, and the teacher should be trained in mathematics, physics and engineering. To carry out such a reform calls for the development of a thoroughgoing laboratory system of instruction in mathematics and physics, its principal aim being to develop the spirit of research and an appreciation of scientific methods.

One of the most important suggestions of the English movement is that by emphasizing steadily the practical sides of mathematics, that is, arithmetical computations, mechanical drawing and graphical methods generally, in continuous relations with problems in physics, chemistry and engineering, it would be possible to give very young students a great body of the essential notions of trigonometry, analytic geometry and the calculus. It is especially important that teachers in the primary schools should make wiser use of the foundations laid by the kindergarten. Cross-section

[12] "Unification of Mathematics in the School Curriculum," W. E. Story, *School Review*, 1903, pp. 832–55.

[13] "Mathematics in Commercial Work," E. L. Thurston, *School Review*, 1903, pp. 585–92.

[14] "Discussion on the Teaching of Mathematics," Perry, Macmillan, 1902.

paper, tables and blackboards should be used all through the grades. Drawing and paper folding should lead to intuitional geometry and mechanical drawing, and geometry be closely connected with numerical and literal arithmetic.[15]

As phenomena are observed by the individual, they should be described graphically and also in terms of number and measure. The graphical depiction serves to illuminate the quantitative determination, and *vice versa*.

The following has been suggested as a fairly complete equipment for a mathematical laboratory:[16]

1. Set of drawing instruments, board, T square, triangles (for each pupil).
2. India inks, paper, note-books, cross-section paper.
3. A large, well-lighted room, good drawing desks.
4. Carpenter's tapes, surveyor's tapes, architect's scales.
5. Three-, five-, seven-place logarithmic tables; pupils to choose which to use from accuracy of data.
6. Logarithmic slide rules and computing machine.
7. Surveyor's compass, transit, level, rod, poles.
8. Surveyor's plane table and sextant.
9. Steelyards, balances, pendulums, barometers, thermometers.
10. Force appliances such as pulleys and simple machines.
11. One hundred good texts on arithmetic, algebra, geometry, trigonometry, physics, elementary mechanics and astronomy, including Crelle's multiplication table.
12. A dozen treatises on these subjects, and a few good histories of mathematics and the mathematical sciences.
13. Spherical blackboards, concave and convex.
14. Three plane blackboards for projective and descriptive work in geometry.
15. Mathematical models.
16. Samples of actual engineering and architectural drawings of machines and structures.
17. Gyroscopic tops.
18. A set of Hanstein's models for projective work.
19. Stereopticon and slides.

The laboratory method has been given a thorough trial at the University School, Chicago, and methods have been developed and text-books prepared from the laboratory point of view. The aim or ideal of the work for the first year has been formulated by Professor Myers as follows:[17] (1) to generalize and extend arithmetical notions; (2) to follow up the notions of mensuration into their geometrical consequences; (3) to reconnoiter a broadly interesting and useful field of algebra; (4) to treat, with sufficient completeness for high schools, a large part of what is most practical and useful in elementary algebra. This means postponing the scientific and purely logical aspects of algebra to a later period.

Problems are drawn from arithmetic, mensuration, geometry, physics and elementary mechanics; and the equation is made the starting point and agency for developing the topics considered. The text-book which represents this first year's work is essentially an extensive and varied body of mathematical ideas correlated around an algebraic core.[18] The treatment begins with the informal methods of inductive arithmetic, passes to the uses of the equation and its transformations, and by degrees assumes a deductive character. Practical problems of a constructional or mensurational character have been found to appeal to first-year pupils with greater drawing force than any other problems of the text.

[15] "On the Foundations of Mathematics," Moore, *School Review*, 1903, pp. 521–38.

[16] "The Laboratory Method," C. W. Myers, *School Review*, 1903, pp. 727–41.

[17] "Year's Progress in the Mathematical Work of the University High School," G. W. Myers, *School Review*, 1907, pp. 576–93.

[18] "First-year Mathematics for Secondary Schools," G. W. Myers and others, University of Chicago Press.

In second-year mathematics geometry holds the center of attention, and arithmetical and algebraic elements are subordinated to it. The distinctive feature of the plan of presenting deductive geometrical truths consists of five general steps. The figure required by the demonstration is first sketched in the rough, in a way to exhibit clearly the conditions under which the truth in question is to be established. A careful drawing is next made on paper or on the blackboard with ruler and compass, under the specified conditions, and the appropriate parts of the figure that are drawn (protractor admitted) are carefully measured. Pupils are then required to make the best possible inferences as to the conclusions which follow from conforming to the imposed conditions. A correct enunciation of the principles to be established is next made and finally a deductive proof is given in standard form.

The mode of conducting the class work is a combination of the laboratory, the experimental, the Socratic and the class recitation modes. One of the advantages of the method is that it impresses the novice with the inadequacy of pure metrical means, and with the necessity of demonstrative methods.

As the result of six years' experience in teaching elementary high-school mathematics, Professor Lennes asserts his belief that graphical work is of great importance in creating interest and promoting a clearer and more satisfactory insight into subjects which too often are mysterious riddles.[19]

Professor Myers supplements this by saying that laboratory work with real problems, in the formulation and handling of which the pupil habituates himself to the transition from the concrete to the abstract, goes far toward supplementing the present isolated and abstract teaching of secondary mathematics.[20]

THE PHILOSOPHIC ATTITUDE

The reforms proposed by Professor Perry emphasized the practical features of instruction. In geometry especially there was a radical departure from Euclidean methods in the direction of the utilitarian. This tendency, however, is not universal. Objection is raised by a certain school of pure mathematicians to any system of mathematical instruction which is not severely logical, and which considers the subject as a means rather than an end. The following views of Professor Halsted may be considered as typical of this demand that mathematics be taught from the outset as a formal training in rigorous thinking.[21]

Halsted asserts that there must be a course in rational geometry which is really rigorous. This course should be founded on a preliminary course which does not strive to be necessarily demonstrative, but should emphasize the constructive phase. The purpose of the preliminary course should be, as Hailmann has said, to develop clear, geometrical notions, to give skill in accurate construction, to cultivate a healthy, esthetic feeling, and the power of visualizing creatively in geometrical design, thus stimulating genuine, vital interest in the study of geometry.

This preliminary course must fit the rigorous treatise on rational geometry which Halsted says should be written by some one familiar with the new, penetrating, critical researches in the principles of geometry.

Instead of agreeing with Professor Perry that many of the theorems in Euclid might well be assumed as axiomatic, Halsted as-

[19] "The Graph in High School Mathematics," N. J. Lennes, *School Review*, 1906.

[20] "Laboratory Equipment," Myers, *School Review*, 1903, pp. 727–41.

[21] Halsted, *Educational Review*, Vol. 24.

serts that greater rigor should be introduced, quoting Hilbert as saying that it is an error to believe that rigor in the proof is the enemy of simplicity.

With the new powers of insight given by the non-Euclidean geometry, and the introduction of Lobachevski's new principle in geometry, it was found that even Euclid made implicit assumptions. Thus, to make an angle congruent to a given angle involves a continuity assumption, while to prove other propositions requires a new set of assumptions which Halsted calls "betweenness assumptions," viz., of any three points of a straight line, there is always one, and only one, which lies between the other two.

The Euclidean method of superposition is also characterized as a worthless device; for if triangles are spatial but not material, there is a logical contradiction in the notion of moving them, while if they are material, they can not be perfectly rigid, and when superposed they are certain to be slightly deformed from the shape they had before.

Furthermore, so-called hypothetical constructions found in most text-books are criticized as illogical. Thus, certain propositions may require the construction of a regular heptagon or the trisection of an angle, although such constructions are impossible by elementary geometry. Thus, in many constructions, existential propositions are assumed. Helmholtz says of this: "In drawing any subsidiary line for the purpose of demonstration, the well-trained geometer asks always if it is possible to draw such a line."

This leads to the importance of not placing too great reliance upon diagrams. Bertram Russell says of Euclid I., that the first proposition assumes that the circles used in the construction intersect, an assumption not noticed by Euclid because of the dangerous habit of using figures. Hilbert believes in making frequent use of figures, but never depending upon them. The operations undertaken on a figure must always retain a purely logical validity. Halsted says that the beginners' course should consist largely in becoming familiar with figures, while in rational geometry that treatment of a proposition is best which connects it most closely with a visualization of the figures.

In rigorously founding a science, he believes that we should begin by setting up a system of assumptions containing an exact and complete description of the relations between the elementary concepts of this science. These axioms are at the same time the definitions of these elementary concepts. No statement within the science should be admitted as exact unless it can be derived from these assumptions by a definite number of logical deductions.

This criticism of the Perry movement and the laboratory method of instruction has recently been summarized by Professor Halsted as follows:[22]

> We knew that the so-called laboratory method for mathematics, the "measuring" method, was rotten at the core, since mathematics is not an experimental science, since no theorem of arithmetic, algebra or geometry can be proved by measurement; but, even granting the impossible, granting the super-human power of precise measurement, we could not thereby ever prove our space Euclidean, ever prove it the space taught in all our text-books.

THE PRACTICAL VIEW OF MATHEMATICS AS THE EXTENSION OF EXPERIENCE

One of the most sane and sensible views of the teaching of elementary mathematics yet presented is due to Professor Simon Newcomb.[23]

After recognizing the great difficulties

[22] "Even Perfect Measuring Impotent," Halsted, SCIENCE, October 25, 1907.

[23] Newcomb, *Educational Review*, Vol. 4.

inherent in the subject, Professor Newcomb goes on to say that in the teaching of elementary mathematics, especially arithmetic, care should be taken to embody mathematical ideas in a concrete form. The difficulty with the beginner is that he has no clear conception of the real significance of the subject which he is working upon. Figures and algebraic symbols do not represent to his mind anything which he can see or feel. So long as this continues his work consists of formal processes which have no correspondence in the world of sense.

Although a single experience may suffice to establish certain conceptions, it does not follow that the mind can apply these concepts in reasoning. It is one thing to know what a thing is but quite a different matter to handle it. This suggests that the difficulty in the teaching of elementary mathematics may be somewhat obviated by showing the mathematical relations among sensible objects.

To illustrate, not much progress was made in the study of imaginaries in algebra until Gauss and Cauchy conceived the idea of representing the two elements which enter into an algebraic imaginary by the position of a point in a plane. The motion of the point embodied the idea of the variation of the quantity, and the study of the subject was reduced to the study of the motion of points; in other words, an abstraction was replaced by a concrete representation. The result of this simple representation was that an extensive branch of mathematics was created, which would have been impossible if the abstract variable of algebra had not been replaced by the moving point of geometry. If such concrete representation is essential for expert mathematicians, it is obvious that immature pupils should be offered the same advantage.

In arithmetic, it is suggested that graphic methods be used throughout by way of illustration and explanation, lines being drawn to represent the numerical magnitude of the quantities involved. *Actual measurements, however, should not be made, but magnitudes should be estimated by the eye.*

This statement is especially noteworthy, as the idea implied seems to reconcile the differences between the ultra-practical and the ultra-logical extremes. The great danger in the laboratory method is that it will develop manual dexterity at the expense of intellectual power, or, from the ethical standpoint, that it will sacrifice the ideal to the material. The one pedagogical principle universally recognized, and the one on which it is claimed that the laboratory method is based, is that instruction should proceed from the concrete to the abstract. However, with the extensive laboratory equipment suggested by the advocates of the laboratory method, there must be a tendency, through lack of time if for no other reason, to remain with the concrete without making any sensible advance toward the abstract. Professor Newcomb's suggestion regarding the graphical depiction of relations without measurement, visualizes the idea to be presented without waste of time or involving the question of accuracy of measurement. The latter obviates the essential objection to graphical methods raised by Professor Halsted and others, and thus goes far toward meeting all demands, both critical and practical. Its simplicity, and the fact that this method has been, and is, in constant use, is also in its favor, and must appeal to all teachers who are interested in the progress of their pupils rather than in the exploitation of novel ideas.

It is also suggested that for at least one half the sums given in arithmetic, there be substituted a course of calculation of sizes,

weights and values of familiar things, such as, finding the dimensions of the schoolroom, the number of square feet in the floor and walls, the number of cubic feet in the room, the weight of the air in the room, the weight of the walls of the whole building, the number of bricks, etc. These would be more interesting than the complicated problems given in some of the advanced arithmetics.

Professor Newcomb deplores the fact that students who have taken a college course in physics can not compute the quantity of water which would be evaporated by the heat generated by the combustion of a ton of coal; or the number of cubic feet of air which could be warmed in the same way. He says that there is no good reason why this kind of elementary physics should not form a part of arithmetic, except adherence to traditional customs characteristic of the district school, and the prejudices of the so-called practical men against everything scientific in education.

In the study of geometry, the pupil should begin with constructive problems solved graphically; in beginning algebra, the pupil should first thoroughly familiarize himself with the use of symbolic language. Algebra is a kind of language, and to be proficient in its use this language must be learned by practise like any other unusual or foreign language.

Newcomb concludes by saying that it may be true that by adopting these suggestions the pupil would not get through any one book more rapidly and would make no better show of his knowledge upon examination. The advantages to be gained would be fewer courses, through fewer details of arithmetical applications being necessary, and a greater facility in the applications of arithmetic, algebra and geometry to practical questions.

A somewhat similar plea for practical mathematics is made by Fitzga in his work on natural methods of instruction.[24] The author first emphasizes the fact that in practise the use of mathematics arises from some external cause and that only concrete comprehensible things create a demand for its use, such as the coins, measures and weights in common use. The fact that numbers can not be seen, and that they are only phases of observation (*Beobachtungsmomente*) makes it necessary to present to the child's mind such objects, from which he can through observation fix numbers. In this selection much is gained if objects are chosen which will awaken interest. The things that interest the child most are those that are used in life, and such things as the child sees handled by adults. In the beginning of arithmetical instruction, therefore, numbers should be derived from different parts of the body, such as the fingers, eyes, etc., and later from arithmetical magnitudes (*Rechnungsgrössen*). These things are at first to be used for the purposes of observation lessons, for in this manner number presentations will be grasped without difficulty.

There is no question but that an exact knowledge of the mathematical magnitudes of life is necessary for the child, but the present methods of presentation do not permit of the exact observation of them. The child can not, through such a process, grasp the idea of magnitude, nor the relation of measures and their parts, and without this knowledge there can be no understanding of the subject. The observation of arithmetical magnitudes does not depend upon the physical properties of the objects observed, but upon the relation which they bear to one another. There are in each observation lesson certain vital features to

[24] "Die naturliche Methode des Rechenunterrichtes der Volks und Burgerschule," E. Fitzga, Wien, 1898.

which the observation of the child should be directed, and with such practise, numeration and figuring will follow of necessity. The aim of arithmetic should be chiefly to emphasize those arithmetical magnitudes which relate to practical life, and these should be presented to the child as objects of observation.

In order to determine the subject matter, it is necessary to consider that positive phases of the subject considered relate to practical life and in how far through the consideration of the subject matter can the moral and the cultural side of the child be nurtured.

The present lesson plans expect too much of the observational and comprehensive powers of the child, and it is certainly not a loss to the child if in the first-year arithmetic is not taught. In emphasizing the fundamental idea that numeration and arithmetical operations are chiefly to be acquired through the observations of arithmetical magnitudes, Fitzga expressly states that he does not approve of the rigorous handling of the subject matter. This, he says, naturally *assists the child in acquiring thoughtless habits.*

The conception of a thing only becomes clear when it is the abstraction of many similar and clear presentations. For this reason a teacher should not develop principles during a lesson in arithmetic, but should discourage the use of principles even by the brighter pupils, who have grasped these principles during the process of development, for the weaker pupils will immediately use them, and will not trouble themselves to acquire them through a process of logical reasoning. The teacher who wishes to bring his pupils to a clear comprehension of arithmetical problems can not develop any principles, but must wait until the child shall see the principles himself in the progress of his work.

Instead of the rigorous treatment of the subject, and the development of principles, Fitzga has, therefore, divided the separate parts of the subject matter into elements from which follows a logical arrangement based on the idea of repeated observations and presentations necessary to form clear conceptions of the different arithmetical operations.[25]

He also points out that it is necessary to choose examples in such a way that the context of the problem is comprehensible to the child. For this purpose it is necessary to bring to the mind of the child the various relations of practical life, out of which the examples are taken, and this can be done by giving a system of logical observation lessons.

The method of giving observational lessons as the basis of mathematical instruction has been explained in considerable detail by Jackman.[26] The article referred to is primarily a plea for the correlation of mathematics and physics, on the ground that mathematics has become so isolated that it is universally considered as the bugbear of the curriculum. This, it is stated, is due to the fact that the problems deal with subject matter with which the pupil has no concern, and mathematics has thus become simply a science of empty processes.

The question of the hour in the teaching of mathematics is not how do pupils in their thinking develop ideas of exact quantitative results, but ideas of what quantitative results are worth developing.

The unfortunate position in which mathematics finds itself is also partly due to the mistaken idea that a constant manipulation of mathematical formulas has a peculiar disciplinary value, whether they give any decidedly useful results or not. Great

[25] For courses in detail see his book, mentioned above.

[26] Jackman, *Educational Review*, Vol. 25.

mathematicians, however, have always acquired their disciplined powers while in the pursuit of knowledge having intrinsic worth, which indicates that mathematics should be related to actually useful and related things.

The past decade has seen a revolution in the schools. The old-time school with its barrenness of resource has been abolished, and the pupil has been placed in direct contact with all the vital activities of his time. To-day the child thinks through his hands, and it is currently believed that mathematics can play only a limited part in the new education. Yet since the whole universe is a manifestation of energy, mathematics must find its place in every subject. As a matter of fact, it is closely identified with physics and has already found its place in biology, botany, zoology, etc.

A radical change in the usual methods of presenting the mathematical branches must be made. Instead of taking them tandem fashion, the subjects of arithmetic, geometry and algebra must go hand in hand. The child solves the question for himself by introducing them all at once even before he enters school. It becomes then simply a question of assisting the pupil in the further development of the mathematical powers which he began to employ spontaneously before he came to school at all.

To illustrate the preceding principles and methods an outline of some work done in the eighth grade of the University Elementary School (Chicago) is given. The subject was botany and the pupils were allowed to take their time to work out the problems, as their observations demanded. In doing the work, the following principles were observed:

1. There must be a clear, general notion of the image to be developed.

2. There must be a careful selection of appropriate units of measurement.

3. The most expeditious methods of measurement or of applying the units must be chosen. Estimate first; then measure.

4. There must be a careful selection of processes by which the comparisons are made.

5. This must be followed by an objective representation of the results in the form of data obtained by observation. Gallons, quarts, pints, feet, yards, square feet, square yards, acres, miles, etc., must be seen until they become a part of the mental equipment.

6. Using the results obtained as data, a great nature picture must be constructed. That is to say, through the original and primary conception under which the pupil has been working, the real magnitude of world operations should be made to appear in definite quantitative results.

To illustrate these principles, the dispersal of seed was chosen as subject matter. The observation material in this case was found in a vacant city lot adjoining the school, and by extending the calculations to allied subjects, such as the amount of solar radiation, and of annual rainfall, the fundamental operations of arithmetic were thoroughly covered. The details of the work are fully explained in the last-mentioned article.

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WILLIAM EIMBECK, 1841–1909[1]

Mr. William Eimbeck, the subject of this sketch, and myself were close friends for many years. His ambitions were well known to me, and I am very well aware that his failure to attain the final success he had hoped for was due to an organic disease which slowly crept upon him during the later years of his life.

[1] Memorial address before the Philosophical Society of Washington, May 22, 1909.

He was born January 29, 1841, in Brunswick, Germany, and beginning his education in the public schools and gymnasiums of his native city, he came to the United States at an early age and completed his training as civil engineer under private instruction in St. Louis. His first professional experience was in connection with the building of the Eads bridge at St. Louis, and in the offices of the St. Louis City and County Engineers. Later for two years he was professor of mechanics and civil engineering in Washington University.

In 1869 Professor J. E. Hilgard, the assistant in charge of the Coast Survey and later its superintendent, had organized a series of parties to observe the solar eclipse of August 7 of that year. Mr. Eimbeck was an enthusiastic volunteer observer and was assigned to the party of Julius Pitzman, county engineer of St. Louis, and stationed near Mitchell, Ill. After the eclipse he took part in the determination of the latitude and longitude of St. Louis, and the connection of the various eclipse stations in Missouri and Illinois with this base station. His enthusiasm and success in this work led to his selection as an observer in the expedition organized by Professor Benjamin Peirce, then superintendent of the Coast Survey, to go to southern Europe to observe the solar eclipse of December 22, 1870. Mr. Eimbeck was assigned to the party of Professor C. H. F. Peters, the distinguished astronomer, with whom he observed the eclipse on Monte Rosso near Catania in Sicily. His ability, acquirements and enthusiasm displayed on these two expeditions led to his appointment on the Coast Survey, July 1, 1871, and his connection with it continued for thirty-five years.

His first assignment was to one of the triangulation parties on the survey along the thirty-ninth parallel of latitude which was operating in Missouri, extending the work westward from the base in the Great American Bottom opposite St. Louis; and later he was engaged in astronomical duties in connection with determination of latitudes, longitudes and azimuths in Kansas, Texas and Louisiana.

In 1872 he was assigned to the Pacific coast and for five years was engaged in astronomical and primary triangulation work along that coast from Oregon to the entrance of the Gulf of California; one of his undertakings being a determination of the geographical coordinates and magnetic elements at thirteen stations between San Diego and Cape San Lucas for the control of the survey of the coast and Lower California then in process of execution by the Navy Department. In 1872 in the superintendent's report is an evidence of the thorough spirit in which he entered upon securing a thorough command of all the details of the scientific operations upon which he was engaged, this being shown by his paper suggesting improvements in the Hipp chronograph then used in connection with the telegraphic longitude operations.

In 1877 he returned to the eastern coast, where he was assigned to an extensive astronomical and magnetic campaign for determination of latitudes, longitudes and the magnetic elements in Kentucky, Illinois, Tennessee, South Carolina and Georgia, and later, after making the necessary preparations, in 1878 he was again assigned to the western coast and began at Pah Rah in Nevada the extension of the primary work eastward from the coast triangulation, which was to follow approximately the thirty-ninth parallel of latitude to the capes of Delaware. This was the inception of what was to be the main life work of Mr. Eimbeck and to which for eighteen years he gave all that was best in both mind and body. Stretching from the Sierra Nevadas to Pikes Peak and the east line of the Rocky Mountains, and including in its list of occupied stations mountain peaks reaching an elevation of 14,400 feet, in regions where supplies had to be carried for hundreds of miles through deserts and wastes, destitute of roads and almost destitute even of water; the successful conduct of this work called for the endurance of the most rugged of pioneers, the undaunted courage of the explorer, while the operations represent the highest type of

work demanded from the scientist and observer. In this triangulation one line, observed in both directions, is over 183 miles long and is not exceeded in the work of any country.

There are two instances where the change between adjoining stations necessitated a journey of 300 miles, one of these being the transfer of parties from Mount Ellen to Mt. Tavaputs, made under fierce suns of August and September, across a desert section which tested almost to their limits the endurance of the men and animals, and it is remarkable to relate that in his most expansive moments Eimbeck never seemed to consider that any special merit could be claimed for successfully overcoming all these hardships and dangers. A reference to the annual report of the superintendent will emphasize this feature of our friend's character, as therein will be found only a simple statement of the work completed each year, because of the modesty which would not permit him to give adequate account of the toils he faced and conquered.

Near the close of this great triangulation, Mr. Eimbeck designed the duplex base apparatus which was constructed at the Coast and Geodetic Survey Office and used by him in the measurement of the Salt Lake base.

In addition to the field work upon which he was so actively engaged, he was always deeply interested in every branch of the work of the survey, and specially those pertaining to geodesy. In 1900 he undertook an elaborate series of experiments for the study of the seasonal range in the value of the coefficient of refraction, but a final report was never received from him; although he made several announcements of the satisfactory progress he was making in the perfection of a theory for this important term. His study of the question of the existence of sensible tides in the earth's surface had also occupied his attention for many years and was the object of study with him up to his last days. It is known that he gave profound study to the problems of the tides, gravity, the causes of the variations of latitudes, etc., and it is also known from his own statements that he was preparing his theories for publication. The most frequent references to Mr. Eimbeck by his intimate associates are appreciations of his suggestive and illuminating discussions of many of the problems that attract the physicist and astronomer, and all the problems to which the geodesist gives attention.

In appearance Mr. Eimbeck was the elegant and distinguished gentleman. Tall, erect, of fine proportions and handsome features, he was often admired as he walked the streets of Washington carrying an overcoat on his arm, which he disdained to wear even in the coldest weather. In his early days he was of robust health, but as early as 1890 he began to complain that he could no longer endure either the physical or mental strain of former years. A few years later he thought he had Bright's disease, but would not consult a physician. This disease, with the complications that so frequently come with it, slowly crept upon him, till in 1906 he resigned from the survey, hoping a life free from care would improve if not restore his health. It was too late—he gradually failed, and finally on March 27, 1909, his death resulted from a stroke of paralysis.

Mr. Eimbeck was a founder member of the Cosmos Club, for thirty years a fellow of the American Association for the Advancement of Science, a member of the Washington Academy of Sciences, of the National Geographic Society, of the Geological Society and of the Washington Philosophical Society.

In closing this sketch of the life of Mr. Eimbeck, I wish to quote from a little notice that was issued to the members of the Coast and Geodetic Survey a few weeks since:

> A lifetime of study and research added to charming natural eloquence and marked clarity in exposition made Mr. Eimbeck one of the most interesting and instructive companions, these distinguished qualifications being set off by a modesty as extraordinary as the merits it failed to obscure. Broad and tolerant in his sympathies and with no thought for self in his generosity to the unfortunate, the life just closed is one that can justly claim only praise when it is referred to, and affection when it is recalled.

EDWIN SMITH

THE PROTECTION OF NATURAL MONUMENTS

ABOUT a year ago I caused to be distributed broadcast in this state a circular inviting local public attention to the importance and desirability of protecting our natural memorials. Though behind this call there has been neither organized effort nor public funds, there is good evidence that in some instances the suggestions embodied in the circular have been seriously entertained and perhaps may have had some practical result. Such efforts, it would seem, must be essentially localized at the start and perhaps, to effect the best results, should remain so.

The conservation of especially interesting natural monuments comes somewhat late in the development of the sentiment of a community, with the increase in the appreciation of nature's works. There are lovers of birds who see with profound regret the disappearance of certain of their friends once common in the region, but gradually driven away by the encroachments of commerce upon their nesting places. There are lovers of plants who know the few remaining spots where rare flowers bloom or rare ferns may be found. What comparison does a loyal citizen make between a noble tree which has seen the centuries roll by, which has stood sentinel over the community since the cradle days of the settlement, and the light or telephone company which lops off one of its branches to let a wire go through or thrusts an ugly pole into its boughs? A wooden telephone pole with its cross-trees is to-day in our cities and villages the cross on which every sentiment of good and decent taste is crucified. There are persons in almost every community who can be better spared than some of its venerable trees. It is not only the age of a tree that entitles it to guardianship; there are some which have especial associations with distinguished personages of the past, others may be the last survivors of a race which once abounded but whose companions have disappeared under the woodsman's axe. A great glacial rock boulder projecting alone from some meadow or hillside, tells a romantic age-long story which should not be menaced by the workman's sledge. There are bits of swamp still profuse in rare orchids, and clumps of woodland where rare birds still nest but which will soon be robbed of their possessions if measures are not taken for their protection.

No part of any of our states is without such objects which appeal to the thoughtful citizen for protection—the lesser objects which could not be well brought within the supervision of societies of national scope, like our American Scenic and Historic Preservation Society, or even of recognized state organizations. In my circular I undertook to indicate some of these minor objects which had come to my notice within this state as entitled to protection either for their intrinsic character or their historic associations, such as the rock bridge over the Perch River; a burless chestnut near the village of Freehold, unique in the state; an arbor vitæ of enormous size on Lake Colden; the extinct volcano near Schuylerville, which served as "Stark's redoubt" in the campaign of 1777, and so on. It would be no difficult matter to complete a census of such objects which might serve as a guide to local interest and contribute much to the general attractiveness of any community. Our American culture does not run easily to sentiment and opportunities for conserving such natural memorials lightly pass, only to be followed by regret for their loss; for the opportunity once gone, it is forever too late; the damage once done can never be repaired. And it is worth while saving these things, for lovers of nature and the out-of-doors, students of science and of history, intelligent members of every community in this and in the generations after us, will approve the doing.

In such a movement we have to take our lesson and inspiration from the older and higher culture of Germany, where substantial progress has been made in protecting such objects of natural interest. There the methods employed and the results achieved are interesting. An old fir tree gnarled with years in the forests of Lueneburg is set apart and protected for its very age and fascinating ugliness. A little patch of dwarf birch, a

rare survivor of the postglacial flora, is preserved and protected in the vicinity of Hamburg. A considerable area of forest near Münster is protected because of its profusion in certain rare species of lichens. In Schleswig a great glacial boulder resting on a low knoll has been set aside, the ground immediately about it acquired and a road laid out to it. In Brandenburg a little lake with its swamp, the Plage, has been reserved on account of its botanic interest and in Marienwerder a bit of lake and woods where rare water birds nest. A local society in Gotha has acquired a small pond and swamp and has transferred to it rare plants threatened with extinction and has also introduced new plants foreign to the region, such as our common *Sarracenia* or Pitcher-plant. Such results as these have been attained largely through the activity of local societies and are the outcome of local pride and intelligent appreciation, but Prussia has an official duly appointed by the Cultus Minister as State Commissioner for the Care of Natural Monuments, Dr. H. Conwentz, director of the Provincial Museum at Danzig, and through his activity aided by the official forestry organization, much has been possible which would be more difficult here without such aid. The methods employed by Dr. Conwentz have enlisted a more than local interest and the Cambridge Press has recently published his address on his work delivered by request before the British Association last year.

It is not likely that any American state will very soon accord recognition to this movement by following the example of Prussia in designating an official as its apostle to arouse local loyalty and supervise such conservation but the whole matter, it would seem, might with entire propriety be embraced within the scope of the national conservation movement whose official support could be so enlisted and so delegated as to efficiently enforce the subject on public and local attention and even on private munificence. I am not aware that the functions of the National Conservation Commission are so restricted as to restrain it from taking cognizance of this growing favorable sentiment toward such conservation as I have indicated and if such authority may properly be assumed by it, it would be no difficult matter to find some active spirit in each state to whom the moral and official support of the commission might be given in the furtherance of so laudable an undertaking.

John M. Clarke,
Director, Science Division

Albany, N. Y.,
June 16, 1909

THE DARWIN CENTENARY AT CAMBRIDGE[1]

The Darwin celebration, which began on June 22, is a remarkable event in university annals. Commemorative festivals, held at one or other ancient seat of learning, have been frequent in recent years; but their object has been to celebrate the foundation of some famous institution in the distant past. And there have been festivals of a different kind in honor of one or other of the great names on the roll of intellectual achievement, whose glory has been established and consecrated by the long lapse of time. But no such academic tribute as the present festival has ever been paid to the memory of an individual within so short a time of his own life.

The great and ancient University of Cambridge is devoting three days to it, and the whole learned world from Chile to Japan is joining in homage to the memory of an Englishman who was with us but the other day. Some of those who will be present were his comrades, most of them have been in some measure his working contemporaries. Two hundred and thirty-five universities, academies and learned bodies at home and abroad have nominated delegates to represent them; and of these 167 are situated in foreign countries and British dominions outside the United Kingdom. Thirty of the most famous institutions in Germany, thirty in the United States, fourteen in France, ten in Austria-Hungary, eight in Italy, as many in Sweden, seven in Russia and lesser numbers in seven other foreign countries have honored the occasion by naming some of their most distin-

[1] From the London *Times*.

guished members to take part in it. The distant seats of learning in the younger British countries have responded with not less cordiality; seven in Canada, seven in Australia, five in New Zealand and the same number in South Africa have appointed delegates; India and Ceylon are represented by eight. Within the United Kingdom 68 universities and societies are lending their support; and, in addition to the appointed delegates, there are some 200 invited guests, who include men eminent in every walk of life.

A share in evoking this extraordinary manifestation of world-wide respect belongs, of course, to the prestige of Cambridge University, which is acting as host; but Cambridge could not have planned a festival on this scale or sent out the invitations in honor of a lesser man. Other great men were born in the famous year 1809, and one at least was at Cambridge; but it is impossible to conceive a pious pilgrimage of this sort to celebrate their birth. It helps us to realize the immense space on the intellectual horizon of the world filled by the figure of the great observer and generalizer. His achievement has, in a sense, become so familiar, its indirect influence has so closely interpenetrated the general consciousness of mankind that we can hardly see it plain or measure its proportions. It is not a matter for the learned only, but for all of us. To no other man has it been given to effect a revolution in human thought so large, so pervading, so sudden, and yet so enduring. Darwin taught mankind to see all things in a new light, not only the operations of nature, great and small, the mysteries of existence and the innumerable objects of research, but the common things of every-day life.

SCIENTIFIC NOTES AND NEWS

YALE UNIVERSITY has given its doctorate of science to Dr. E. W. Morley, emeritus professor of chemistry at Western Reserve University; to Dr. Wm. T. Sedgwick, professor of biology at the Massachusetts Institute of Technology, a graduate of the Sheffield Scientific School, and to Dr. E. H. Moore, professor of mathematics of the University of Chicago, a graduate in arts and philosophy at Yale University.

DR. S. F. EMMONS, of the U. S. Geological Survey, has received the doctorate of science from Harvard University.

WASHINGTON AND JEFFERSON COLLEGE has conferred the degree of doctor of science on Dr. C. H. Townsend, of the New York Aquarium.

THE delegates to the Darwin commemoration on whom the degree of doctor of science was conferred by the University of Cambridge are: Édouard van Beneden, professor of zoology at Liége; Prince Roland Bonaparte, Paris; Geheimrat Bütschli, professor of zoology and paleontology at Heidelberg; Robert Chodat, professor of botany at Geneva; Francis Darwin, F.R.S., honorary fellow of Christ's College, and formerly reader in botany; Karl F. Goebel, professor of botany at Munich; Ludwig von Graff, professor of zoology and comparative anatomy at the University of Graz and president-elect of the International Zoological Congress which meets at Graz next year; Richard Hertwig, professor of zoology and comparative anatomy at Munich; Harold Höffding, professor of philosophy at Copenhagen; Jacques Loeb, professor of physiology in the University of California; Edmond Perrier, director of the Natural History Museum of Paris; Gustav Albert Schwalbe, professor of anatomy at Strassburg; Hermann Graf zu Solms-Laubach, professor of botany at Strassburg; Clement Timiriazeff, professor of botany in Moscow; Frantisek Vejdovsky, professor of zoology in the Bohemian University of Prague; Max Verworn, professor of physiology at Göttingen; Hermann Vöchting, professor of botany at Tübingen; Hugo de Vries, professor of botany at Amsterdam; Charles D. Walcott, secretary of the Smithsonian Institution at Washington; E. B. Wilson, professor of zoology in Columbia University, New York; and Charles René Zeiller, professor of paleobotany in the École des Mines, Paris.

AT the commencement of Harvard University on June 30 the degrees of doctor of laws

and doctor of medicine were conferred on Dr. Charles W. Eliot, who has been made by the corporation president emeritus of the university. In conferring these degrees President Lowell said: "Charles William Eliot, teacher, administrator, orator, prophet; forty years the leader and the guide of Harvard, and in the single-minded elevation of his character a model to her sons; the father of the present American university, the brother of all teachers and the friend of every lover of his country: It has not been our custom to confer the degree of doctor of medicine, *honoris causa;* but an exception is fitting in the case of one who, in the opinion of professors of medicine, has accomplished more for the progress of medical education in this country than any other living man, Charles William Eliot. Not in its buildings alone, but also in the instruction and research within its walls, he found our medical school brick and left it marble."

THE Royal Society of Arts has awarded its Albert medal to Sir Andrew Noble, K.C.B., F.R.S., "in recognition of his long-continued and valuable researches into the nature and action of explosives, which have resulted in the great development and improvement of modern ordnance."

M. J. VALLOT has been elected by the Société des Observatoires du Mont Blanc director of the observatory founded by the late M. Janssen. He is now director of two observatories on Mont Blanc.

MR. A. F. CRIDER has resigned the directorship of the State Geological Survey of Mississippi and Dr. E. H. Lowe, formerly professor of geology in the University of Mississippi, has been elected to the position.

DR. JOHN H. MUSSER, professor of clinical medicine at the University of Pennsylvania, is chairman of the American delegation to the International Medical Congress, which will be held this year in Budapest.

UNDER the direction of Professor Charles Lane Poor, of Columbia University, an expedition has been fitted out to measure the tidal currents of Point Judith and Block Island. Professor Poor will supervise the work from his yacht "Weetamoe"—the station boat being the auxiliary power boat "Gracie." The observations will be made by Messrs. Brainin and Ladd.

EDWIN F. STIMPSON, assistant professor of physics, University of Kansas, has obtained leave of absence for one year to accept a position as inspector of weights and measures in the Bureau of Standards. At the last session of Congress, an appropriation of ten thousand dollars was made for an investigation in regard to the efficiency of the inspection service in the different states, to ascertain to what extent fraud is practised in interstate commerce. The bureau proposes to send inspectors to the different states to advise with the local authorities and to assist them in procuring the proper equipment and in adopting uniform regulations. The appropriation is only for one year and every effort will be made to cover the country, and to be in position to render a final report to congress by next June.

MR. J. W. JENKINSON, demonstrator at the Natural History Museum, Oxford, has been elected a fellow of Exeter College.

PROFESSOR CHARLES L. EDWARDS, of Trinity College, expects to spend the next fifteen months in Europe. During the present summer he will work in one or more of the Scandinavian marine biological stations, from October to March with Professor Boveri at Würzburg and then in the spring at Naples. In the summer of 1910 he expects to attend the Eighth International Zoological Congress at Gratz.

THE Danish government has sent an expedition under Captain Elmar Mikkelsen to Greenland to search for the bodies of Mylius Erichsen and the other explorers who perished in November, 1907.

IT is said that Professor Hergesell will have charge of a dirigible airship under the general direction of Count Zeppelin, which will next year undertake explorations in the polar regions and if it proves feasible will undertake to reach the North Pole.

DURING the recent commencement week of the Ohio State University two memorials were presented by the alumni. An oil portrait of James Hulme Canfield, fourth president of Ohio State University and later librarian of Columbia University. This was painted by Mr. George Bellows, of New York City, an Ohio state man. The second memorial was a large bronze tablet for Townshend Hall, one of the agricultural buildings of the university. This tablet contains a life-size medallion portrait of Dr. Townshend and the following inscription:

TO THE MEMORY OF
NORTON STRANGE TOWNSHEND
1815–1895
BELOVED PHYSICIAN, FRIEND OF THE
CAUSE OF HUMAN FREEDOM, WISE LAWMAKER,
A PIONEER IN AGRICULTURAL EDUCATION,
ONE OF THE FOUNDERS OF THIS UNIVERSITY
AND ITS FIRST PROFESSOR OF AGRICULTURE
THE STUDENTS OF AGRICULTURE
AND OF VETERINARY MEDICINE
HAVE PLACED THIS TABLET
A.D. 1909

WE regret to announce the death, June 20, at Copenhagen, Denmark, of the distinguished naturalist and physician, Dr. Rudolph Bergh, well known among zoologists for his work on the nudibranchiate mollusks.

THE U. S. Civil Service Commission announces an examination on July 14, to fill a vacancy in the position of editor, in the bureau of education, Department of the Interior, at a salary of $2,000 per annum. The duties of the position will be performed chiefly at Washington, and will include correspondence, report writing, editing and the preparation of original articles concerning the various phases of education. There will also be occasional work outside of Washington studying educational institutions and problems, attending conferences, and giving addresses at important public meetings. It is desired to secure in the appointee selected one having a broad general education who has also specialized in the study of education and has a wide knowledge of educational literature, including current publications, so that he will be able to give advice and to furnish information concerning matters which may be of interest to the educational public at any given time. It is not essential that he should be skilled in the preparation of copy or in the reading of proof. Men only will be admitted to this examination.

HARVARD UNIVERSITY has received an anonymous gift of $5,000 to establish a fund, the annual income of which is to be used for the support of a summer field course in structural or stratigraphical geology, conducted preferably in the mountain region of western North America, for the benefit of students who have an elementary knowledge of the subject.

MR. F. G. SMART has given the University of Cambridge £600 to establish two prizes to be awarded each year in botany and in zoology.

A RESEARCH studentship in actinotherapeutics, of the annual value of £300, to be known as the Douglas research studentship, has been established at Guy's hospital, London.

MR. FRANK SPRINGER has presented to the museum of the University of Colorado a collection of more than fifty species of fossil Crinoids and Blastoids.

THE Rhode Island legislature at the last session appropriated $2,500 annually for three years for a survey of the natural resources of the state. The work was placed under the general charge of the Bureau of Industrial Statistics, Colonel George H. Webb, commissioner, who has appointed Professor Charles W. Brown, head of the department of geology at Brown University, to take immediate direction of the survey. Mr. Nelson C. Dale, A.M., and I. R. Sheldon, '10, have been appointed field assistants.

THE Illinois State Laboratory of Natural History has recommenced biological work on the Illinois River and dependent waters at Havana (Illinois), in continuation of the work interrupted in 1899. The plan of operations involves an ecological and economic study of the entire river system, to include both the plant and animal contents of the waters, and their relations to the environment in general and detail. The work is in charge of Dr. S. A. Forbes, director of the laboratory, with Mr. R. E. Richardson as resident assis-

tant at Havana. A committee on an ecological survey appointed by the Illinois Academy of Science, of which Dr. Forbes is chairman, is associated with this work in an advisory capacity, and the members of the committee will share in its investigations. The station is equipped with a floating laboratory, a gasoline launch and the various apparatus necessary for aquatic collection and investigation. It is the intention of the management to open the station to biological and ecological investigators during the summer of 1910.

THE third meeting of the permanent commission of the International Seismological Association will take place August 30 to September 4, at Zermatt, Switzerland.

THROUGH the kindness of Professor Lambrecht and Dr. Davies, of the University of Leipzig, arrangements have been made for a special room for Americans who visit the celebration at the 500th anniversary of the founding of Leipzig University. This room is at the Goldner Bär, Universität Strasse 11. Americans should register at this place and they will here be given any information that they need for the celebration.

UNIVERSITY AND EDUCATIONAL NEWS

AMONG gifts to Yale University announced at the recent commencement were $100,000 to establish a John Sloane memorial fund for the increase of salaries and two gifts of $20,000 each towards the establishment of a professorship of education. It is further announced that a compromise has been effected in the case of the will of Frederick C. Hewitt, by which the university will receive $400,000.

THE Drapers' Company have renewed their grant of £2,000 (£400 a year for five years) to the department of applied mathematics in London University under Professor Karl Pearson, thus enabling the research work in statistics and in the biometric laboratory to be continued and extended. The Mercers' Company have made a grant of £500 to the department of physiology.

THE new Institute of Physiology at University College, London, was opened on June 17 by Mr. Haldane, the secretary of state for war.

DR. HENRY B. WARD, of the University of Nebraska, has accepted a professorship of zoology in the University of Illinois.

DR. RAYMOND H. STETSON, of Beloit College, has been appointed professor of psychology at Oberlin College.

DR. FRANK N. FREEMAN, who for the past year has held the traveling fellowship in philosophy and psychology from Yale University, has been appointed instructor in educational psychology in the University of Chicago.

MR. CLINTON R. STAUFFER, A.M. (Ohio State) has been appointed instructor in geology in Western Reserve University.

PROFESSOR CHARLES E. DECKER, now in the graduate school of the University of Chicago, has been appointed instructor in biology and geology at Allegheny College for the coming year.

APPOINTMENTS and promotions in the St. Louis University School of Medicine are announced as follows: Dr. M. F. Engman has been made professor of dermatology in place of Dr. John H. Duncan, resigned. Drs. J. W. Marchildon, J. J. Honwink and R. D. Carman have been advanced from instructors to assistant professors of bacteriology, dermatology and "roentgenology," respectively.

DISCUSSION AND CORRESPONDENCE

"THE DAYLIGHT SAVING BILL"

TO THE EDITOR OF SCIENCE: The reference to the bill in SCIENCE for June 18, 1909, page 973, in the interesting letter of "T. C. M." is not quite accurate. The bill was introduced in the Indiana legislature and provided that the ratio of the circumference to the diameter of the circle should be exactly three to one. It was referred to "The Committee on Swamp Lands." The introducer of the bill evidently had never heard of π, and if he had, would probably have considered it a symbol of traditional New England breakfast dish.

The published report of the hearings before the special committee of parliament on the "Daylight Saving Bill," from which the

following quotations are taken, does not indicate that it is supported by many distinguished men of science. It was testified that the "Science Guild" of which Sir Norman Lockyer is chairman, and which is composed of "scientific people or people who take an interest in science" feels "that it is a great mistake to tamper with time." The bill was strongly opposed by Sir William H. M. Christie, the astronomer royal, and Sir David Gill, who was recently his majesty's astronomer at the Cape of Good Hope. It was through the influence and active work of the latter that standard time was substituted for local time in South Africa in 1903. The bill was favored by Professor Rambaut, professor of astronomy in the University of Dublin, and Sir Robert S. Ball, formerly astronomer royal of Ireland, but both of these gentlemen strongly opposed the proposition to set the clocks one hour ahead. They favored the idea of making three changes of twenty minutes for the summer, returning to Greenwich mean time for the winter; in other words, the long-hour and short-hour plan. To this the practical objections are very great and it is understood that its advocacy before parliament has now been definitely abandoned.

Sir William H. M. Christie called attention to the fact that neither Sir Robert Ball nor Professor Rambaut, when in Ireland, had "succeeded in persuading their countrymen of the advantages of early rising which might have been secured by substituting Greenwich for Dublin time, the Irish clocks being thus put twenty-five minutes forward," although they tried to do so.

The tenor of all the arguments in favor of the bill was that many persons would be deceived into getting up earlier by setting the clocks ahead when they could not be persuaded to do so otherwise.

It is reported in the daily papers that many English employers have voluntarily arranged to have the day's work of their employes commence a half hour or an hour earlier in the summer, thus securing honestly the advantage it is claimed people would gain by changing the clocks and without "juggling with the uniform measurement of time" as Sir William Christie properly terms it.

When the mass of the English people come to fully realize that by shifting the clocks an hour ahead they will be adopting a time *made in Germany,* perhaps their patriotic impulses will induce them to come to the assistance of common-sense people and make any attempt to pass the so-called "Daylight Saving Bill" absolutely hopeless.

W. F. A.

NEW YORK CITY

A REMARKABLE AURORA BOREALIS

ONE of the brightest auroras seen in recent years at Blue Hill Observatory was visible for several hours on the evening of May 15 last. When first observed, at 8:58 P.M., it formed three detached luminous patches, the two brightest having been near the zenith. At 9:10 P.M. the latter two merged to form one large bluish-gray mass, of unusual brightness. After that, the luminosity changed rapidly from moment to moment, while the form was altered but slightly, the whole mass moving slowly to the south and west. For about three quarters of an hour the main mass took the shape of a long-handled dipper, the bowl appearing like the head, and the handle like the tail of a huge comet, which many people thought the phenomenon to be. At 10:36 P.M. it was seen as five detached areas of light, which, after about ten minutes, joined to form an unbroken arch which reached from west to east almost entirely across the sky, the highest point passing slightly to the south of the zenith. After 11 o'clock the arch broke up into separate masses which changed in brilliancy from time to time, but gradually faded until all had disappeared by 11:30 P.M. In the two hours from 8:59 P.M. to 10:59 P.M. the mass moved as a whole about 25° toward the south and about 50° toward the west, as measured from a point near the center of the main mass which was originally about 5° to the north of the zenith. After 10 o'clock we had the unusual condition of the "northern lights" entirely to the south of a west-to-east line through the zenith. It is also worthy of note that the southern border was at all times a

distinct and clean-cut line, while the northern border was everywhere indefinite, gradually dying out at about 30° to the north of the zenith. During the course of the evening the luminous area varied in width from 10° to about 35°.

The aurora was remarkable on account of its unusual position, its rapid changes in brilliancy, and its varying shape. The color was a pale bluish-gray, no iridescence having been seen at any time. Moreover, there was no suggestion of streamers or rapidly-moving iridescent patches, often referred to as "merry-dancers." When the aurora was at its maximum brilliancy, only the stars of brightest magnitude could be seen in that region of the sky, and the "milky way" was rendered entirely invisible. Over nine tenths of the sky was cloudless throughout the evening, a trace of alto-stratus cloud having been visible above the northern horizon, and an equal amount of cumulo-nimbus cloud with distant lightning having been seen far off to the west.

Andrew H. Palmer

Blue Hill Observatory,
May 17, 1909

SCIENTIFIC BOOKS

Elements of Optical Mineralogy, An Introduction to Microscopic Petrography. By N. H. Winchell and Alexander N. Winchell. New York, D. Van Nostrand Company. 1908. Pp. 502; 350 figures; 4 plates. Price, $3.50.

During the last few years several excellent treatises on optical mineralogy by Americans have appeared, namely, those by Luquer, Iddings and Johannsen. According to the authors, none of these contains a concise and clear exposition of the principles, methods and data of optical mineralogy. It is to supply this want that this text was written.

The book is divided into three parts, as follows: (1) Principles and Methods, (2) Description of Minerals and (3) Analytical Tables.

In part one, seventeen pages are devoted to some of the phenomena of light, twenty-two pages to the elements of mineralogy, and fifty-nine pages to the application of polarized light to crystalline substances. Part two contains a systematic description of all the rock-forming minerals concerning which there is sufficient data to permit their being determined by means of the microscope. These descriptions occupy 310 pages. Part three is made up of exhaustive analytical tables for determination, microscopically, of rock-forming minerals. The tables extend over fifty-seven pages.

There are also three appendices, as follows: (1) Optical Study of Opaque Minerals—ten pages, (2) Microchemical Methods—nine pages, and (3) A Partial Bibliography—two pages.

There will be, undoubtedly, much difference of opinion among petrographers and physical crystallographers as to whether the authors have succeeded in presenting the principles and methods, fundamental to a clear understanding of the physical properties of rock-forming minerals, "concisely and clearly." To be sure, they have been treated concisely, but only in a few cases clearly. Thus, the description of the nicol prism, a thorough understanding of which is absolutely essential, is intelligible only to those who have had some previous knowledge of it and know what to expect. Certainly a beginner can obtain no clear conception of it. Furthermore, the description is not entirely accurate, as is shown by the following sentence, lines 7 to 10, page 16: "The cut faces, after polishing, are cemented together again in their original position by Canada balsam—*which has nearly the same index of refraction as the Iceland spar*" (the italics are the reviewer's).

The statement, page 8, that the most exact method of applying total reflection to the determination of the index of refraction is the Kohlrausch method, is misleading, as any one who has had experience in applying it knows. Line 9, page 9, should read "the axis of the observing telescope *OT* is the line of the *reflected* ray," instead of the incident ray. Fig. 3*c*, accompanying this description, is poorly executed, the line *ON* being by no means normal to the plate *OD*. In fact, many of the

drawings are not up to the usual standard, especially that set by German writers.

In the discussion of the elements of mineralogy a brief review of the essentials of crystallography is undertaken. It would seem that altogether too much space is given over to the calculation and projection of crystals and not enough emphasis placed upon a mastery of their general morphology. For after all, the petrographer is far more concerned about the general features of crystal form, as revealed in the thin section, than he is about the calculation to the fourth decimal place of the elements of crystallization.

In the chapter on the application of polarized light to crystalline substances the optical behavior and methods of determination of crystals are treated. In too many cases are the phenomena, to be observed, described without any attempt being made to explain them. This is especially the case with the discussion of the formation of uniaxial interference figures. The statement on page 46, "The student must keep in mind the principles of polarization of light as given in Chapter II.," needs to be corrected, as polarization is not at all referred to in the chapter indicated.

Parts two and three are the most important features of the text. The descriptions of the various minerals are in all cases full and include, aside from a discussion of the crystallographic, optical and other physical properties, paragraphs treating inclusions, recurrence, diagnostics and classification. Many figures showing the optical orientation accompany these descriptions. The discussion of the feldspar group is very exhaustive, covering forty-seven pages and including fifty-four figures. The analytical tables are well arranged and usually lead to a rapid and accurate determination of the mineral under consideration.

Although the authors have failed to present the principles and methods of optical mineralogy in a manner which will allow of a ready comprehension by the beginner, they have nevertheless succeeded in making easily accessible the more important data of rock-forming minerals. This feature alone is sufficient to commend the book to the use of advanced students of petrography and physical crystallography.

EDWARD H. KRAUS

MINERALOGICAL LABORATORY,
UNIVERSITY OF MICHIGAN

Gold: Its Geological Occurrence and Geographical Distribution. By J. MALCOLM MACLAREN, D.Sc. Cloth, 6×10 ins., pp. 687. London, The Mining Journal.

Maclaren's "Gold" is a recent acquisition to a somewhat overworked field of endeavor. The work has been compiled, as such works must needs be, through much painstaking effort extending over a number of years; an important consideration being that a large part of the information presented has been verified by investigations made by the writer which add weight and authority to the statements.

The book is divided into two parts, namely, the General Relations of Auriferous Deposits and the Geographic Distribution of Gold. In the first part is a general discussion of the occurrence of gold, including a general statement regarding the structure of the earth and its relation to ore deposits. There is a brief discussion concerning the zone of fracture, sources of metallic ores and underground waters, filling of fissures, secondary enrichment, etc., but it is doubtful whether they should not have been discussed at greater length or not considered at all.

There is an interesting section devoted to a discussion of the physical and chemical characters of gold, its alloys and natural compounds.

The geological occurrence of auriferous deposits is taken up under the head of Classification of Deposits, which is divided into two groups, the primary and secondary, the occurrence by countries, districts, etc., being considered under these heads. It is needless to say that an attempt to cover the occurrence of gold throughout the world in seventy odd pages is much too big a task to be done comprehensively.

The bulk of the book is devoted to a discussion of the geographical distribution of gold, and while fairly exhaustive leaves much

to be desired from the standpoint of details, and details which are essential to a clear and comprehensive discussion of the localities in which gold is found and its associated minerals.

The book is well written, and while it contains much of interest it is doubtful whether it fills any great and pressing need which is not already occupied by other works. An important and valuable feature is the comparatively large number of references embodied in the text to which the reader may turn for verification of stated facts or to extend his information. Its chief value lies in the fact that the occurrence of gold is given for the whole world and not for some particular country. To those who enter upon the study of precious metals, a keen regret must be experienced in the perusal of such a work, that both of the precious metals, gold and silver, could not have been considered together, owing to their intimate association in ore deposits and their relations to commerce and industry in the world's community. In many respects this work is a valuable addition to the literature on the occurrence of gold, and will be welcomed by many.

Walter R. Crane

SCIENTIFIC JOURNALS AND ARTICLES

The June number (volume 15, number 1) of the *Bulletin of the American Mathematical Society* contains the following papers: Report of the April meeting of the society, by F. N. Cole; Report of the April meeting of the Chicago section, by H. E. Slaught; "A Set of Criteria for the Summability of Divergent Series," by W. B. Ford; "On Fredholm's Equation," by P. Saurel; "The Chicago Symposium on Mathematics for Engineering Students," review by H. W. Tyler; "Osgood's Calculus," review by C. N. Haskins; "Shorter Notices": Bachmann's Grundlehren der neueren Zahlentheorie, by J. W. Young; Whitehead's Axioms of Descriptive Geometry, by F. W. Owens; Jouguet's Lectures de Mécanique, and Andoyer's Cours d'Astronomie, by W. R. Longley; "Notes"; "New Publications."

The July number (concluding volume 15) of the *Bulletin* contains: "Tautochrones and Brachistochrones," by E. Kasner; "Degenerate Pencils of Quadrics connected with $\Gamma^{n+2}_{n+4,n}$ Configurations," by W. B. Carver; "On the Use of n-fold Riemann Spaces in Applied Mathematics," by J. McMahon; "Mathematical Appointments in Colleges and Universities," by E. J. Wilczynski; Picard's Algebraic Functions of Two Variables, review by J. I. Hutchinson; "Shorter Notices": Correspondance d'Hermite et de Stieltjes, by James Pierpont; Scott's Cartesian Plane Geometry, Part I., Analytical Conics, by E. G. Bill; Hilbert's Grundlagen der Geometrie, third edition, by A. R. Schweitzer; Klein-Schimmack, Vorträge über den mathematischen Unterricht an den höheren Schulen, Part I., by J. W. A. Young; "Notes"; "New Publications"; "Eighteenth Annual List of Papers read before the Society and Subsequently Published"; Index of Volume.

SPECIAL ARTICLES

DIPLODIA DISEASE OF MAIZE (SUSPECTED CAUSE OF PELLAGRA)

For about two years the writers have been studying the *Diplodia* disease of corn now serious in some parts of the country, with especial reference to its manner of infection. An examination of a bundle of maize plants sent from the west in 1907 indicated pretty clearly that the infection of the cobs was from within, *i. e.*, from the interior of the stem by way of the root system, and not simply a local attack as hitherto supposed. The mycelium was found in all the inner parts of many stems from roots to cobs and in the interior of the latter, and the kernels were moldy (white).

In February, 1908, pot experiments were started in one of the hothouses to verify this inference, the soil being inoculated with pure cultures of the fungus. On June 2 in one of the pots the *Diplodia* was found fruiting on the roots and at the base of the stem, and the mycelium of the fungus was found in the interior of the root, stem and cob in abun-

dance, but not anywhere on the *surface* of the plant except at its base. The mycelium extended upward inside this stem two thirds of its length. On another plant in this pot *Diplodia* was also found in fruit on the crown, and the mycelium was present in the interior of the stem but did not extend upward for any distance.

On the same day in another pot the mycelium was found in the parenchyma and bundles of the roots of one plant. Pieces of the roots were put into damp chamber and in five days the pycnidia of *Diplodia* appeared in great numbers.

The same day in a third pot the mycelium of *Diplodia* was found not only in the interior of the roots but also in the interior of the first two internodes of the stem, from which pure cultures of it were obtained. Here again it was not present on the surface.

The next day in a fourth pot *Diplodia* was found fruiting on the stem in the first four internodes as a result of the presence of internal mycelium. This mycelium was also demonstrated in the interior of the fifth internode, and pure cultures of it were obtained from the interior of this stem. Generally the pycnidia were most abundant at the nodes. They occurred also on the leaf sheaths.

The following summer (1908) the experiment was repeated in a plot out of doors by means of soil inoculation with pure cultures, but, owing to a late start and the fact that the plants had to be dug up early to make room for a new building, the experiment was a failure, except that there were indications of infection in the basal nodes and internodes of two plants. Experiments are under way again this summer.

There seems little doubt that the manner of infection indicated is the common one, *i. e.*, from the soil into the roots, from these to the interior of the stems, and thence upward to the cobs, and finally to the kernels, but it is not unlikely that certain soil conditions may favor or hinder the root infection. This remains to be worked out. Unquestionably the *Diplodia*, like the *Fusarium*, is a soil organism persisting from year to year in infected fields, which for this reason should be staked off and planted to other crops than corn.

It is also worthy of inquiry whether this fungus may not be the cause of the so-called "cornstalk" disease prevalent among cattle in the west. It is also possible that to *Diplodia* should be referred the great numbers of deaths of negroes in the south during the past three years from the so-called pellagra, following the consumption of moldy cornmeal and moldy hominy. This fungus (*Diplodia*) is also a cause of moldy corn in Italy. The only other fungi we have reason for suspecting in this connection are species of Aspergillus. The writers would be very glad to receive for study samples of hominy or corn meal suspected of being the cause of pellagra.

ERWIN F. SMITH,
FLORENCE HEDGES
LABORATORY OF PLANT PATHOLOGY,
BUREAU OF PLANT INDUSTRY,
DEPARTMENT OF AGRICULTURE,
WASHINGTON, D. C.,
July 23, 1909

SOCIETIES AND ACADEMIES

THE GEOLOGICAL SOCIETY OF WASHINGTON

AT the 218th meeting of the society, held at the Cosmos Club, on Wednesday evening, April 14, 1909, Mr. David White presented as an informal communication some notes on the "Kent Coal Basin of Southern England." Calling attention to Professor E. A. Newell Arber's paper in the February number of the *Journal of the Geological Society of London*, in which the fossil plants from the deep drillings near Dover, England, are described, he pointed out that the three workable coals, 1,881–2,377 feet deep in the Waldershare core, are paleobotanically either Mercer or Clarion in age, probably the former, though both ages may be represented. The boring about 6 miles farther south, on the coast, cuts 13 coals between 1,100 and 2,270 feet, in a more arenaceous series, also of older Pennsylvanian age. The drillings therefore indicate a considerable number of workable coals in the basin (Kent) passing beneath the Channel at Dover.

Regular Program

Débris Tracks on the Domes of the Yosemite Region: Mr. F. E. MATTHES.

The Yosemite landscape is characterized by many large expanses of smooth, bare granite. Over these different things move or have moved at various times: water in sheets, rills and streams, snow and glacial ice, and with each of these carriers, rock débris in varying quantities and states of comminution. As a consequence these rock surfaces are scored, marked and striped in sundry ways. The nature of these different markings is well understood; yet there is one kind among them that appears scarcely to have received recognition, namely, that produced by creeping rock débris. It is on gently inclined surfaces, such as obtain on the crowning portions of the Yosemite domes that the conditions are most favorable for their development. Loosened rock fragments here slide or creep down at the rate of perhaps but a few inches annually. The frictional resistance of the smoothly curved granite surface being very slight, but little force is required to propel the fragments in downward direction. Probably a number of agents are involved, but snow and water no doubt furnish most of the necessary energy. As the fragments advance they leave trails or tracks behind, conspicuous by their whitish color. Close inspection reveals that these consist simply of paths from which the lichens and mosses that cover the rock surface everywhere and give it its subdued grayish tint have been cleared off. So slow is the progress of the débris, however, that the removal of the lichens can obviously not be attributed to mechanical abrasion. Picking up a fragment one finds its base invariably embedded in a pad of loose rock grains. Now lichens can not live under even the thinnest film of sand. The explanation therefore seems to be that the pad of sand grains kills the lichens under it, and as it moves along with the larger fragment, leaves a clean swath behind. The process is evidently as effective on a small scale as on a large one. On the little-frequented slopes of Liberty Cap and the other lesser domes of the upper Yosemite region, where the débris has a chance to travel year after year, undisturbed by man or animals, rocks of every size down to that of a pea were observed, each at the lower end of a whitish track of proportionate width. Some of the tracks were but a few inches long, but many of them measured several yards. On a bared portion of the rock floor of the Little Yosemite Valley the phenomenon is revealed on a grand scale and wholesale fashion. Several acres of smooth granite here appear blotched, as it were, with a multitude of long whitish stripes and streaks. The débris by which the latter were produced, however, has long since vanished and the rock floor has now a clean-swept look. The cause of the disappearance of the débris may be inferred from the character of the tracks. The latter frequently fork downward, once or several times in repetition. The rock fragments, probably of glacial origin to begin with, must have disintegrated on the way, falling apart in successively smaller pieces, until at last they were resolved into little heaps of loose rock grains that were easily swept away.

Observations on the Recent Calabrian Earthquake: Mr. C. W. Wright.

This paper was published in the *National Geographic Magazine* under the title of "The World's Most Cruel Earthquake," and no abstract is therefore given here.

At the 219th meeting of the society, held at the Cosmos Club, on Wednesday evening, April 28, 1909, Mr. David White presented an informal communication on "Graphic Methods of Representing the Regional Metamorphism of Coals." He exhibited a map covering a portion of the Appalachian trough on which the fixed carbon of the coals (ash and moisture free) was platted according to the location of analyzed samples and contours were drawn showing the degrees of devolatilization in passing from the western margin of the coal field to the Anthracite regions. This method not only shows successfully the progressive devolatilization, as the result of deep-seated thrust pressure, of the coal, the greatest alteration marking the greatest pressure, but it also illustrates the fact that folding and faulting, though valid as proof of thrust action, did not always attend the greatest devolatilization, since they, in some instances, undoubtedly gave relief from long continuance of possible maximum pressure, while pressures, perhaps lower but exerted for a longer time, without relief by plication, in contiguous areas, effected greater changes in the fuel. The method was recommended as direct, without recourse to ratios, and simple, being based on proximate analyses. It illustrates in a striking way the improvement of the bituminous coals as the result of regional metamorphism. A similar platting and "contouring" for the same area, of the carbon-oxygen ratios (dry coal, the oxygen compensated for sulphur) show these contours not only to conform in general to the fixed carbon contours, but also better to express the regional changes in the "heat value" of the coals.

Regular Program

Geology of the Mexican Oil Fields: Mr. C. W. Hayes.

Geology of the McKittrick-Sunset District, California: Mr. H. R. Johnson.

The Temblor Range, along the northeast slopes of which the McKittrick, Midway and Sunset oil fields of California are located, includes, besides a limited amount of granitic and metamorphic rocks of pre-Cretaceous age, unaltered sedimentaries of Cretaceous, Tertiary and Quaternary age. Briefly the formations comprising the unaltered sedimentary series are as follows:

Knoxville-Chico (Cretaceous) Sandstone.—These include between 7,000 and 12,000 feet of dark green, well laminated and usually nodular shales with intercalated sandstones which predominate in the upper portion of the series. Some of the sandstone includes zones of hard chocolate brown nodules of considerable size, which give the beds an appearance typical of the Cretaceous in the region. The Cretaceous was probably deposited upon an eroded surface of the pre-Cretaceous metamorphic complex known as the Franciscan formation in the Coast Ranges.

Tejon Sandstone (Eocene).—This series of yellowish brown somewhat nodular sandstone with a small amount of intercalated clay shale reaches a maximum thickness of about 2,500 feet. It extends from the Devils Den and Antelope Valley region southeast with considerable continuity along the northeast flank of the range nearly to Temblor Ranch. Although a non-conformity between the Tejon and Knoxville-Chico series is known to exist, there is little field evidence of this condition in the region.

Wagonwheel Formation (Oligocene?).—This is a local occurrence of sandstones and several layers of white diatomaceous shales which appear to be of Oligocene age upon paleontologic evidence. If this determination is correct it marks the first discovery of marine Oligocene in the San Joaquin Valley of California. The beds are located in the isolated group of hills south of Bartons and northeast of the Point of Rocks in the Devils Den District.

Vaqueros (Lower Miocene) Sandstone.—This is a fairly continuous and usually easily recognizable massive yellow sandstone including a couple of fossiliferous reefs which, because of their superior hardness, are easily traceable for long distances. The formation is well distributed over the field and is of variable thickness, its maximum probably being east of Annette, where over 2,000 feet has been measured. Elsewhere the formation is less than 100 feet thick.

Monterey (Lower Middle Miocene) Shales.—Characteristic areas of this siliceous and calcareous formation exist at a number of points in the region. The largest of these areas occupies the bulk of the Temblor Range from west of Temblor Ranch southeast to the limit of the region studied. It is exposed on either flank of the range for a number of miles northwestward from this mass and overlies the Vaqueros sandstone conformably. The maximum thickness measured, in which, however, the beds may be doubled by close overturned folding, is about 4,000 feet, a thickness considerably less than the Monterey at other points in the state. At the base of the Monterey there are beds of sandstone transitional into the Vaqueros and at several horizons in the formation similar sandstone lenses occur. In a general way it may be stated that the lower half of the Monterey includes a higher proportion of calcareous and siliceous shales than the upper part, in which the diatomaceous facies becomes more prominent.

Santa Margarita Formation.—This formation includes rocks of considerable variety, but along the northeast flank of the Temblor Range heavily bedded diatomaceous shales are characteristic of it. While the formation rests unconformably upon the Monterey there is little difference in dip between the two series, and except for greater hardness in the older and the predominance in portions of the field of diatomaceous shale in the younger formation, there is slight stratigraphic basis for their separation. Southwest of Midway the characteristic diatomaceous shales of the Santa Margarita are intercalated with lenticular beds of heavy granitic material which offers striking contrast to the very fine organic shales with which they are associated. The great difference in texture and origin of these two facies is indicative of remarkable topographic or climatic oscillations during the period of deposition of the Santa Margarita, and presents an interesting question for future solution. The total thickness of the Santa Margarita is about 1,500 feet.

Etchegoin-Jacalitos Formation.—This term has been rather loosely applied in the field to a series of clays, soft shales, gravels and loosely consolidated sands which lies unconformably above the Santa Margarita. It is of wide distribution throughout the region and its uppermost beds are the latest to have suffered deformation. Its thickness is very variable but the maximum may be stated as about 2,000 feet, although upon the

southwest side of the Temblor Range a thickness of 3,700 feet has been measured.

Quaternary Deposits.—The fluviatile sands, clays, soils and gravels which are the results of erosion since the latest deformation in the region, have been included under this head. Exception to the above statement must be made with regard to some of the gravels along the San Andreas fault line, upon which movement and resulting deformation have taken place even within historic times. Such a classification will exclude all except the stream alluvium and fine material skirting the range and some of the gravel remnants left upon the canyon slopes above the present drainage lines. Along the margin of the San Joaquin Valley there is the usual type of fine material, a result of the coalescence of detritus from a number of sources. Some small valleys of Quaternary material lie at several points within the mountain ranges but except in the larger examples the material has not been mapped.

Structure.—The structure of the McKittrick-Sunset region is very complicated. In general, the range may be considered as a block faulted upward along either side at such a recent date, geologically speaking, that the escarpments so produced have been well preserved. Accompanying this faulting were developed a number of major anticlinal structures, the axes of which are not exactly parallel with the axis of the range, but diverge from it at a low angle toward the southeast. The result of this folding has been to produce a number of prominent salients extending southeasterly away from the main range. Toward its southern extremity the structure of the Temblor Range is affected by the Tehachapi uplift. This is well exemplified in front of McKittrick in the Elk and Buena Vista hills, the structural axes of which swing toward the east and at some places are almost at right angles to the trend of the main range. Here even more than elsewhere in the United States the structural conditions play a very important part in the accumulation of petroleum, and in consequence the folds and faults have been studied and mapped with considerable care, especially in the Sunset, McKittrick and Midway fields; special maps having been prepared which indicate the relations between the structure and the oil developments already made.

Oil Resources of the McKittrick-Sunset District, California: Mr. Ralph Arnold.

François E. Matthes,
Secretary

THE NEW YORK ACADEMY OF SCIENCES
SECTION OF BIOLOGY

A regular meeting of the section was held at the American Museum of Natural History, May 10, 1909, Mr. Frank M. Chapman, chairman of the section, presiding. The following papers were read:

Bufo agua in Bermuda: Professor Charles L. Bristol.

The Relation between the Taxonomic Characters of Crickets (Gryllus) and the Environment: Dr. Frank E. Lutz.

The speaker stated that the species of *Gryllus* are distinguished chiefly by the actual and relative sizes of the ovipositor, posterior femora, wings and tegmina. The length of the ovipositor is correlated with the character of the soil, being longer on sandy soils than on the firmer ones. This is probably brought about by selection destroying the eggs which are not deeply placed in loose soil. The length of the wings seems to be a function of three variables: ancestors, heat and moisture. Increased heat and moisture are accompanied not only by an increased percentage of the long-winged dimorphs, but by a greater wing length of the short-winged group. No relation has been discovered between the size of the posterior femora and the environment. These conditions bring about marked differences between the crickets in different habitats, and these differences are of "specific" rank.

Deleterious Ingredients of Food: Dr. E. E. Smith.

It was shown in this paper that food itself is deleterious if ingested in sufficient quantity. This is not an essential quality of food, but one dependent on the quantitative relation. Any ingredient added to food is deleterious in the quantitative sense, precisely as food itself is. The statement of the Food and Drugs Act, June 30, 1906, "an article shall be deemed to be adulterated, in the case of food, if it contain any added poisonous or other added deleterious ingredient which may render such article injurious to health" is to be interpreted as referring to ingredients that are essentially deleterious. Substances that serve a useful purpose in amount widely separated from the quantity that may produce injurious effects are not essentially deleterious, even though they may become deleterious by abuse of the quantitative relation.

Frank M. Chapman,
Secretary pro tem.

SCIENCE

FRIDAY, JULY 16, 1909

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

RESULTS VS. IDEALS IN TECHNICAL EDUCATION [1]

RESULTS *vs.* ideals; performance *vs.* promises; accomplishments *vs.* good resolutions; graduating classes *vs.* college catalogues and prospectuses—such is life!

This is a commemorative occasion; a twenty-fifth graduation; a proper time to look backward and revise educational estimates.

Chauncey Rose, the revered founder of Rose Polytechnic Institute, had very definite ideals. His thought was of an education blending the industrial sciences with advanced academic and even collegiate instruction; the product to be, not scholars only, but men fitted for various mechanical, professional and industrial pursuits; and equipped with both intelligence and skill.

The first president of Rose Polytechnic, the lamented Dr. Charles O. Thompson, came here with very practical ideals, worked out during fifteen years at what is now the Worcester Polytechnic Institute. He transplanted to Terre Haute the system by which adequate scholarship is joined to skill gained by manual training in shops and laboratories. The Russian system in Moscow was contemporaneous; but there all manual operations of shopwork were for instruction only; material was consumed, but for the products there was no use or commercial value. Professor Calvin M. Woodward, in St. Louis, had also worked ten years on the manual training system, in which he aimed to

[1] A memorial address on the occasion of the twenty-fifth graduation at Rose Polytechnic Institute.

teach tool-theory and mechanical analysis apart from ordinary shop-practise—to conduct a secondary school with a liberal course of study in mathematics, science and language. But the Worcester system developed by Thompson and Higgins gave shop training under commercial conditions; the saleable products had a widely recognized use and value.

In his inaugural address, President Thompson clearly set forth the purpose and scope of an institute of technology. He defined the term technology as the application of the sciences to industrial ends. He then deprecated the confusion of ideas which would apply the term, technical education, to *any* course of teaching which aims at a directly practical result, as opposed to the old academic idea of the "college education." But when, as he said, a title is sought for those who engage in the higher occupations or professions, the word technologist is found to be too vague and awkward; hence such men are termed engineers, and the business, engineering.

We may note here that the term "engineering" may seem to lack breadth of meaning, suggesting chiefly mechanical devices, engines, machine shops, etc. But reference to the dictionary will set us right; for the first definition (now obsolete) of engine is "natural capacity," "ability," "skill"; and the derivation is from the Latin *ingenium* which is a composite of *in* and the root of *gignere,* to produce. Hence the original sense is very comprehensive, and the word, as used, quite appropriate. Indeed, the late Geo. S. Morison, civil engineer, held that every engineering work is a tool for accomplishing some specific purpose; that engine is but another name for tool; that the business of an engineer relates to tools; that a civil engineer must be capable of designing as well as handling tools; that the highest development of tools is an engine which manufactures power; that we are in the early stages of a new epoch, that of the manufacture of power; that civil engineering in its true meaning embraces every special branch; that the true civil engineer must be able to design as well as direct; and that, whether he be a railroad builder, a skilful surveyor, a mechanical engineer, or devoted to any other specialty, he must be more than a skilful workman, he must be an originator, a creator.

In President Thompson's statement of the high purpose of Rose Polytechnic, he recognized this principle and emphasized it by announcing that the young men who propose to be civil engineers will spend part of their practise-time in the machine shop. This was then an unusual policy in the schools, but it accorded with the earliest precedents of the profession. The first great civil engineers of the modern world, Perronet in France and his contemporary, Smeaton in England, one hundred and fifty years ago, developed marked inventive power and skill along mechanical lines. They devised and adapted their rude auxiliary machines for constructive purposes. Instead of steam hoisting engines, they had only man power and horse power. Smeaton constructed and operated pumps, water wheels, blowing engines and windmills, and invented astronomical and meteorological instruments.

You may remember the familiar anecdote of Rennie who, when traveling, lost caste among his fellow passengers by mending the broken axle of a disabled stagecoach—but one offended companion was astonished to find him at the breakfast table of a nobleman next day.

To justify his ideals at that time, President Thompson reported, as the results of fifteen years' trial of the system, that more than 95 per cent. of the graduates at Wor-

cester were in occupations for which their training had specifically prepared them: The subsequent twenty-five years at Rose Polytechnic show that eighty-six per cent. have been and are devoted to pursuits relevant to the training received here—including electrical engineering and architecture, which have been added during the period.

But a world-wide view of the ever-expanding field of technical education shows some complexity; there is discordance of results and ideals; criticism is abroad. The president of a leading American university,[2] where science is the leading interest, has recently recognized a prevalent doubt whether scientific studies have the same educational value as the classical curriculum; whether they confer the same depth and breadth of intellectual power; whether the outlook they give is as wide, or the life as large, as that founded on the old college training. Cecil Rhodes, an Oxford man, a phenomenal man of affairs, and would-be empire builder, gave his answer by founding the Rhodes Scholarships. However, to say the least, such criticism is quite premature. The ancient order of education was a growth of centuries; the new is scarcely half a century old. The immense body of knowledge, with its useful applications developed by scientific inquiry during the past two centuries, has but little relation to the ancient learning based on literature, rhetoric and art. The old system produced and still produces too much ineffective culture.

It is almost beyond belief that two distinguished professors in great universities have openly declared that increase in the utility of studies makes them of less value in educating men; and that "The practical aim of a *general* education is such training as shall enable a man to devote his faculties to matters which of themselves do not interest him." One of our honored leaders has termed this "superb foolishness." The modern scientific training aims at efficiency. If there are defects, the remedy is not in going back to the old, but in making one reinforce the other; and in finding a right adjustment of all the complex terms involved.

[2] President Remsen, of Johns Hopkins.

Perhaps it was a sense of the growing complexity of the situation, and a need of some agency of adjustment, that led to the formation of the Society for the Promotion of Engineering Education in 1893. This is the first and, so far, the only society of its kind in the world—a national congress of the teachers of engineering. The choice of its title raised the old question, of education *versus* training. Warning was urged against the danger of putting too much emphasis upon mere training to the neglect of the broader education. Furthermore, was the purpose of the society more truly expressed by the word *technical* or by the adjective *engineering?* It was decided that engineering includes technical, in describing the professional endowment of the man; and that education includes training, as the whole includes the parts—without putting too much stress upon mere drill and manual dexterity. Dr. Calvin M. Woodward, of St. Louis, has well said that the watchword of engineering education is *service*. It is to be in itself essentially serviceable.

> The idea of service underlies every detail of it, and that service is objective, altruistic; and therein it differs from that older education whose supreme object is "culture." . . . We all know that there is more than one avenue to culture; in point of fact there are many avenues, and we purpose to claim for the accomplished engineer his right to full and equal membership in the increasing brotherhood of culture.

Indeed, the term profession, as a vocation, signifies the application of special

knowledge and skill for the use and benefit of others, and not for merely personal advantage. So that a so-called professional man whose sole aim is selfish gain is discredited. Hence the famous maxim of Smeaton reveals the true professional instinct of the engineer. He said: "The abilities of the individual are a debt which he owes to the common stock of public happiness."

Right here we may observe that the most practical product of culture for the engineer is literary ability. From the time of Smeaton's report on the Edystone lighthouse to the latest papers and articles in our technical publications, the writings of engineers lose nothing, but sometimes gain by comparison with other literature of like kind. Instead of creations of sentiment and fancy the engineer deals with plain facts and procedure; knows exactly what he wants to say; and is only concerned to express himself with brevity and effectiveness. His subject-matter almost naturally leads him to adopt the prime qualities of style. He may be classed with other scientists who, in the words of another, "have caught with remarkably close ear the accents of the English tongue."

Doubtless this ability must be cultivated; young graduates do not often have it, for they lack the first essential, that is, having something worth while to say. But they may, and ought to have the preliminary training derived from preparation of required reports on special topics, and the graduating thesis. And many older engineers might have more influence and better professional standing by judicious speech and writing. They hesitate to "speak out in meeting," when it is their duty to inform the community on questions of engineering in relation to public affairs. The late Mr. Eads was a forceful writer and speaker; otherwise he never would have persuaded Congress to authorize the construction of the Mississippi (South Pass) jetties against the opposition of those who advocated the ship canal.

Deficiency in this particular has prevented capable and worthy engineers from gaining proper recognition. So long as the majority of engineers are content to take the attitude and play the part merely of the "hired man," so long will capitalists, lawyers and politicians "run the business" and dictate terms to those who, by their special knowledge and skill, are entitled at least to equal voice in the council, and often to direction of affairs.

The society or congress referred to has appointed committees of investigation which have made extended inquiries and rendered reports; vital questions of general policy and methods have been discussed; and much attention given to details of courses and subjects of instruction. A very brief statement of some of their findings will make the present situation more apparent, and elucidate our theme.

1. *Entrance Requirements* were formulated by a committee which made the ideal too high. In mathematics, they included much of what is known as higher algebra, advanced trigonometry, and facility in use of logarithms; also a wide range of physics and chemistry and extensive work in modern languages. Here was manifest the influence of the extreme dictation of the colleges and universities to the secondary schools. The protest of the latter has become very loud, both in teachers' conventions and in current periodicals. Studies that belong in college, perhaps to the extent of half a year of time, are crowded back upon the high schools and academies, which can not properly do the work, both because of inadequate teaching force and immaturity of many of the scholars. A writer in a leading magazine for May has

charged the higher institutions with ruining the high schools by diverting their strength and chief endeavors from the many pupils who can not go to college to the few who can. He says the people, who build and maintain these schools at great expense, are being cheated out of their proper return by not getting the education best adapted to their needs. A few years ago, the speaker saw an examination paper for admission to our foremost university, requiring solution of a problem in organic chemistry, which the instructors at one academy said would be a hard nut for them, and would require considerable time and some laboratory work for a proper answer. Within two weeks a pertinent criticism, widely circulated, is to the effect that the money for public education should be more wisely spent; that a more consistent system should be built up from the primary grades to the high school; and that the school authorities should then say to the universities: "Adapt your requirements to our best boys and girls."

2. The question of specialization and too much diversity of degrees has received earnest attention. A committee reported that, in 1904, no less than 85 different kinds of engineering degrees were offered, 22 for post-graduate work and 63 for undergraduate. Among these were bachelor of arts in five branches, bachelor of engineering in four branches, plain bachelor in nine branches, bachelor of philosophy in five branches, bachelor of science in twenty-eight lines, including textile industry, sanitary and domestic science and naval architecture; railway, architectural, municipal and sanitary engineering; four doctors and four masters of different designations; seven masters of science in different lines of engineering, and nineteen others, including practical chemist, master of mechanic arts, irrigation engineer, marine engineer, chemical engineer, architect, civil engineer in architecture, architectural engineer, etc. Only twelve of the post-graduate degrees and only 47 of the undergraduate degrees were conferred—that is, about two thirds of all those offered. It would perhaps be unkind and inconsiderate to describe this as *absurd* variety; it certainly indicates hopeless diversity, not to say confusion of ideals. The writer has elsewhere urged that the titles master and doctor in engineering are superfluous, and that it is a mistake to depart from the simplicity and dignity of the titles: civil engineer, mechanical engineer, mining engineer, architect, chemist, or, if you please, consulting chemist, electrical engineer and, possibly, one or two more.

Thousands of graduates from engineering schools during fifty years have proved that men with thorough knowledge of the fundamentals find occupation in all branches of engineering, irrespective of the kind of *degree*. Yes, looking back a century, to the first forty years of the U. S. Military Academy, we find about fifty men (trained to be *military* engineers) becoming chief or resident engineers on the canals and railways built in that period. Among these was Major Whistler who built the railroad from St. Petersburg to Moscow, 400 miles, for the Russian government. Why then give men such distinctive and wordy labels, as though the school had cast them into molds, or already projected them with correct aim at definite targets?

3. On the question of *Graduation Requirements* the president of one of our older engineering schools protested strongly against the tendency to "the crowding of the curriculum"; another against too much attempt to anticipate for one who is yet a student, and whose future can not be dictated by overdoing between narrow limits. The committee on this vital topic

worked out a consensus of actual schedules which allowed 7,450 to 8,100 "hours" for 27 subjects, including language, mathematics, the physical sciences and seven differentiated lines of engineering. From this they prepared an essential curriculum, grouping preparatory studies and engineering subjects into four parallel columns, respectively, for civil, mechanical, mining and electrical engineers. This was for the usual four year course. But if requirements for admission are lowered to the extent of half a year, as just suggested, some four-year courses, as now arranged, must be curtailed at various points.

Hence many raise the point that four years is quite insufficient to fulfil a broad enough program of culture studies and the ideal requirements for graduation. Consequently a growing interest in the five-year or six-year curriculum. The experience of the speaker for more than thirty years has been with a two-year program of studies and practise exclusively in the line of civil engineering—but *preceded* at first by *four* years of preparatory work in college, which, during the last fifteen years, has been reduced to *three* years of collegiate work in language and science, including two years of graphics. The five-year course is about as long as the young man of average financial resources can undertake; and too long for many, who then resort to an intermediate year of actual practise, which always brings more than financial return to the student, in better appreciation of his studies. This question is still under discussion. Professor Perry, of London, has said recently, in correspondence: "May I suggest that you Americans are trying to do too much at college. You are trying to teach *everything* at an engineering college. It seems to me that a college ought to teach a man how to go on *educating himself* after he leaves college. . . . If this is the aim of a college, then a five or six year course is all too long." But the University of Michigan has recently announced a six-year course with three degrees in sequence: bachelor of science, bachelor of engineering and master of engineering.

And Harvard University, within a few weeks, has ceased to debate the question by separating her engineering school entirely from the collegiate or undergraduate courses and making it distinctly a graduate school. Harvard thus tardily recognizes engineering as a profession, on an equality with law, medicine and theology. The fact of such equality has long been evident enough. The practicians in the art of engineering have long levied tribute from widely diverse fields of scientific inquiry. They have profited from the labors of the mathematicians since the days of the Bernouillis and Descartes; only they have discarded mathematical abstractions and made mathematics available as a working tool. The engineers have directed the researches of chemists, metallurgists and biologists to useful ends in the operation of water-works, works of sanitation, rail-making, etc. They have made chemical and bacteriological laboratories a necessary adjunct in various works. A civil engineer vindicated the veracity of Herodotus (discredited by some scholars) by making actual survey of and identifying the margin of the (so-called mythical) lake Mœris, and revealing to the modern world the vast irrigation system of ancient Egypt; thus showing how the British administration of to-day has singular analogy to the policy of Prime Minister Joseph in the control of the irrigation by the government. A civil engineer of to-day rescued the manuscript of Frontinus from neglect by the scholars, and introduced that capable and pains-taking water-commissioner of ancient Rome

to the acquaintance of his confrères, younger by nineteen centuries. This vocation, which thus derives both *interest* and *culture* with *utility* from so wide a range of science, archeology and classic literature, is this anything less than a profession?

Many other subjects have received the serious and constant attention of the society in the endeavor to establish practicable ideals; among them are: Instruction by non-resident lecturers and abuse of the method by lectures; disproportion between laboratory or shop-work and class-room instruction; mixing of preparatory subjects and those of the proper engineering program; waste of time by too much vacation; more work with the individual directly, rather than so much with the class as a whole; instruction in the biography and history of the profession; research laboratories and investigational work by engineering schools; engineering jurisprudence; relation of philosophy to engineering instruction; training for leadership; ought instructors to engage in professional work? and many other topics relating to details of class-work, text-books, methods, etc.

The mere mention of so many and such diverse questions of common interest shows the scope of our theme, but only in part. The relations of engineering schools to polytechnic *industrial* education are worthy of passing notice. The U. S. Commissioner of Education reported in 1907 more than 100 state universities, state colleges, institutions of technology, etc., having an attendance of 33,000 male students classified as studying technology, applied science and engineering. This includes some state colleges of agricultural and mechanic arts which might be termed semi-professional schools, as well as some of the technical institutes. Some are yet in their infancy; resources, clientele and other conditions are widely different. One has been inaugurated in an adjoining state within a month. These and the trade schools or secondary schools which distinctly give *training* for particular occupations are generally fulfilling their purpose, by opening the doors of opportunity to many who otherwise would have no hopeful outlook.

The late Professor J. B. Johnson called attention to the monotechnic schools of Germany which are supported by the state or by the municipalities, and have fine buildings and complete equipment of every appliance needed to prosecute each its appropriate industry; also to the hundreds of special schools, supported by trades and associations, which have abolished apprenticeship, and have thoroughly applied science to give exact training; with the result that the superiority of Germany in commerce, based on the growth of her great industries, has been achieved almost in a generation. The three years of study in the monotechnic schools follow two years in secondary scientific schools (*i. e.*, to include sophomore year in our grading), so that the five years produce scientifically trained *directors* of *industrial enterprises*. Again, the commercial colleges of France, Belgium and Germany are training men qualified by their special education to invade every quarter of the globe as commercial agents and builders of industries.

In the United States, the recent Nelson amendment to the Morrill Acts of 1862 and 1890 gives increased national aid for the extension and betterment of the work of the state colleges of agriculture and the mechanic arts. Several of the states are also giving increased aid, and the state of Illinois has taken the unprecedented action of appropriating $50,000 for the *graduate* department of its university. The latest

movement of a national scope was presented in the Davis Bill before the house committee on agriculture of the sixtieth congress. This proposed, among other things, to provide an appropriation for agricultural and industrial instruction in *secondary* schools. It is open to question whether the general government is not already overburdened by its generous annuities to the state colleges, and whether the action now proposed does not more properly belong to the states themselves; whether it is not too much national interference in state education. This brief survey of abundant and diverse opportunities for various education presents an apparently ideal situation; manual training and "domestic engineering" for immediate industrial use, through grades of the semi-professional to the highest type of technology. Yet many point to the results as entirely disappointing.

Only a few days ago was heard a scathing indictment of the state universities by a prominent manufacturer and large employer of labor in our great inter-ocean metropolis. He advised the states to go out of the "higher education business and send the boys back to their homes to help support the family, instead of being a heavy expense." He is reported as saying: "Instead of teaching young men to seek labor they cause them to despise it, and the students leave the schools with the feeling that they are too good to work, and smart enough to make their living by their wits."

This is an extreme view of a so-called "self-made" and self-educated man. Now your true self-made man is not to be described by the jibe of the cynic, as "one who quit work when half done and then began to brag of the job." Rather are they men of hard sense who have achieved wealth and influence in spite of deprivations; and they compel a respectful hearing. If we ask this hostile critic for specifications he might reply: The schools and colleges do not teach good manners; they do not enforce sufficient discipline; the moral suasion theory is so pushed that teachers are often deprived of the power of discipline; the worst scholars become insolent; that the school life, with its artificial conditions, is so far removed from the matter-of-fact world that scholars are not prepared to grapple with the problems of self-support; that many acquire bad habits and learn to be extravagant rather than thrifty; and that, considering the many who have gained wealth and influence without early advantages, the results from the lavish facilities of to-day are out of proportion to the cost.

Professor Johnson, in arguing for a higher and better industrial education, compared the German system with the great diversity of endeavor in American education as follows:

> The common schools give no special preparation for any kind of employment; the manual training schools likewise fit for nothing in particular; our engineering schools fit for very narrow lines of professional employment, and commonly educate men away from the industrial pursuits rather than towards them; and, as for our so-called commercial colleges, what do they teach beyond arithmetic, book-keeping, stenography and typewriting? Where then does the specific scientific training for the manufacturing and commercial industries come in? I submit that it does not come in at all; that our factories and business houses are largely managed by men of little or no scientific training, who have learned their crafts in the traditional way; who are, however, of an inventive turn of mind and who read the trade journals. They are a great credit to the system that has produced them, and many of them have become self-educated into an excellent state of efficiency; but as a class they are far from the ideal directors of such business, and very far indeed from the standard already achieved in Germany. Their success can in most cases be attributed to the extraordinary conditions offered by a

new and rapidly developing country rather than to any superior ability on their part.[3]

The president of another eastern university has been quoted as saying: "Men go to college now for association and sentiment. It is a four-years' playground." There may be some reference here to the obtrusive intercollegiate contests. On the *unpublished* college calendar the usual sequence is: football, basketball, dramatic performances, glee-club exhibitions, spring track-meets for athletics, "junior promenade" and various festivities, baseball, boat-racing and, lately, in the north, polo. This "traveling show business," in the name of institutions which stand for the highest learning and culture, has the concomitants of notorious betting and the expenditure of thousands of dollars in the traveling expenses of the loyal college "cheering squads." Thus the advantages of sports, allowable in moderation, are lost in wild extremes; thus these distractions from the legitimate work are constant throughout the year; thus some seem to regard this as their chief interest and make a business of play. We have the authentic reminiscence of a graduate of a leading New England university, who remarked at a class reunion: "We would have had a really glorious time here, if it hadn't been for those studies." This is no joke. In another college a professor found, on investigation, that the extraneous activities, such as society matters, college papers, and the various sports and recreations, most of them quite proper and even helpful in their place, might easily absorb all of the time, so as to entirely exclude the real work of the college.

However, we recognize a minority of students who hold aloof from this, in good degree, attend to their proper business, and save the scholarship of the institution. Blessed is the man who has no money for such dissipation; he is not as poor as he thinks he is. It is noteworthy, also, that students of technology are much less affected by this evil; possibly from the majority of technical institutes it is entirely absent; and the speaker may add that all who come under his jurisdiction have to renounce any connection with that sort of thing.

This looks like a strong case for the critics of higher education. But their view is so near sighted that they see only the flaws; their method would be that of the Turk; their cure the guillotine, their doctor the executioner. They overlook the fact that some of the most generous contributors to the cause of higher education have been and are of those who lacked its advantages and know its value. Moreover they fail to notice that this regrettable degeneration of college ideals is more especially among those who, if they have a definite aim, will say it is "general culture," or the uplift of what they term "college life." The representatives of technical education, on their own behalf, do not need to enter a plea of "not guilty," for they can show that schools of technology have saved and will save the situation, in large measure. Do they not supply definite aims and a vital interest in what they are doing? The practise in laboratory and shop brings both mental and manual capabilities into harmonious cooperation. When a man has been out all day or even half a day in field practise, and has his notes to put in shape and check, he has little inclination to go out to blow horns or make bonfires.

The president of Cornell University, only day before yesterday, practically took the same ground in replying to the adverse criticism.

[3] Proc. Soc. for Promotion of Eng. Education, Vol. VI., p. 27.

It is a platitude that the example of the technical schools has revolutionized the programs of the older colleges within a generation; and that their students are prompted to strenuous endeavor, such as is unusual among students in the general courses. Indeed, one college president has commonly said to young men about to enter the engineering courses that they are expected to do about a third more work than the other students.

Nevertheless, as we have already noticed, there is much questioning of results in and among the engineering schools, and doubtless room for improvement. Each institution has its peculiar situation and its own problem. The individuality, determined by past history, traditions, resources, equipment, specific aims, personnel of the instructors and acquired momentum, must persist. We can not entirely harmonize ideals or secure uniformity in results. But all schools and their teachers may share in certain practicable ideals and some possible results which we may term *characteristics* of the best technical education.

In this aspect of our subject we may premise a broader definition, to wit: *Technical education is a course of instruction (including suitable training) which will best prepare a man to adjust himself to his future opportunities in technical pursuits.* Usually the man can not choose as he would; only a few find ideal opportunities after graduation. Most men do not find themselves until they face the responsibilities of their vocation. Hence the unwisdom of trying to make choices (or elect) too closely within the jurisdiction of the school. There should be, above all, a readiness to face the *vicissitudes of choice* afterwards.

A *first* and indispensable *characteristic* is *thoroughness.* "Whatever is worth doing at all is worth doing well." If you say this is an admitted maxim of life in any business, we reply that it is *systematically* violated in the whole range of American education, from the bottom up. There is a woful lack of sanity in overdoing the schooling all along the line, and too little thoroughness anywhere.

We develop this characteristic by living up to certain principles of action. Among these we specify (*a*): *A man must check his work.* Here is a marked contrast to some literary training. It is not enough for the man to *suppose* results to be right, when he hands them in; he must *know* that they are right. In leveling, he must close on his benches within the allowed limit of error; in other surveys, he must close his circuits; in the shop, every piece of his work must pass the tests of the gauges. In the draughting room, every computation must be proved by himself or another, and every drawing verified by methods which he can apply for himself, so that he can confidently invite any scrutiny. Such training makes the man sure of himself, and develops the sense of personal responsibility. This is so elementary as almost to need no statement, yet right here has been much complaint from the practicians. They say that in the attempt to cover too much ground, the schools do not teach the men to do their work well; that the young graduate makes many mistakes; that he does not check his results; that he does not keep a neat note book, or have care enough to take sufficiently complete notes; that he is not sure of himself in use of instruments, and can not be trusted to go ahead without supervision. There is no excuse for this; such fundamental training is the business of the school; whatever else is done, this must not be left undone.

As a case in point, a young man, out of college for an intermediate year of prac-

tise, was ordered to run a line of levels. He declined to use the instrument given him, saying that he had tried to adjust it and found an inherent defect which would vitiate his work; and, as it was a line 125 miles long in a bad country, he could not be responsible for correct results. He was commended for his discretion, given a better instrument, completed the task, and before the end of the year was made assistant engineer with an office in a railroad center. You will say that this is only ordinary caution. True; but many fail at such a point. Others had heedlessly used that instrument without proving it, probably on the assumption that a level is a level, and must do the work in some way. Again, a young graduate on the reclamation service was marked for enforced vacation, when the contractors had failed and work was curtailed. But his chief said, "No, I want to keep him; somehow he always gets results and has them right!"

As tending to thoroughness also we may state as *principle* (*b*): "Do not have too many irons in the fire at once." For the average man in a professional course, about two subjects followed collaterally are enough to engage all of his interest and enthusiasm. This does not rule out one other for culture or relaxation, but that should be according to his own preference and at odd times. Any overburden tends to produce distraction and mental worry, which impair the average accomplishment. Dispersion of the stream in an alluvial channel makes shoal water, concentration makes deep water.

Working on this principle of concentration along two lines secures better *continuity* and more *sustained interest* in a given subject; also it makes more feasible the policy of *individual instruction*, by not restricting the sessions in class-room or laboratory to a set period of minutes or hours. The speaker has used for many years the half-day as a unit period, whether the assignments are for recitation, field-work or laboratory.

In this principle also is included the necessity of judiciously excluding all non-essentials. The body of engineering literature is now so overwhelming in its quantity and range that the most diligent student can only get a glimpse of it; but he can learn to use the indexes and make his own card catalogue, through required reports on assigned topics; also how to unlock the storehouse; how to make his knowledge and elementary skill effective in emergencies.

We have noticed how largely the engineering profession utilizes the results of a wide range of scientific investigation. This gives apparent complexity; hence the division into the several recognized branches. Yet it is no contradiction to assert that a *second characteristic* of engineering education is the domination of a comparatively few controlling principles and methods.

If the members of the graduating class will take a retrospect of their entire four-years' course they may be surprised to find how much it can be boiled down to a not very large residuum of fundamental principles and data. In the applications of mathematics the really important subjects of engineering employ chiefly the more simple rules, methods and formulæ of arithmetic, algebra, geometry (including the analytical), trigonometry and calculus. The more intricate formulæ and the higher theorems are not extensively used even in mechanics of materials, theory of framed structures and hydraulics. The interesting applications of the theory of the higher plane curves in mechanism and machine design are almost the poetry of mathematics. The entire science and method of the graphic statics is plain application of

such simple mechanics as the "polygon of forces" and theorems of moments; and these again are elementary propositions of geometry concerning parallelograms and laws of similar triangles.

Engineering instruction in all the leading institutions is usually differentiated into parallel courses only after the first, second or third half year, because they all stand on this common substructure of correct theory deduced from mathematical and physical laws. In the usual subjects or branches, such as concrete construction, bridges, buildings and arches, municipal engineering (including pavements and streets, sewerage and sanitation, water-supply, etc.), thermodynamics and heat-engines, electrical engineering, etc., each includes a body of special data and detail which may be studied by the student in some essential points, but can only be fully appreciated as applied when he becomes a practitioner. The speaker would urge that in the attempt to spread over so wide a range we may get too far away from our base; he would impress upon the student the ultimate unity and simplicity of the science and art of engineering in the large.

A hydraulic engineer of large practise in mill construction and power development says he is constantly reviewing his mechanics and other fundamental theory, so as to have always at instant command the principles which must be his guide to safe practise. Another, a successful inventor and mechanical engineer, says it has been his habit to read from one to two hours daily in physics, chemistry and electrotechnics, that he may keep posted, and work correctly in his laboratory. His fine library indicates scholarship and culture.

Enough said. We leave it to the student to take some simple principles like the theorems of moments, the law of the parabola or the principle of hydrostatic pressure, and trace them in their various applications throughout the range of engineering practise. For example, the simple principle of hydrostatic pressure so beautifully applied in the operation of bear-trap dams and automatic lock-gates—as on the Chicago drainage canal. The chief of the U. S. Engineer Corps has invented about fifteen forms of such dams and gates, some of which have been adopted with great success. The practicians are ever urging us to stick to the main principles and not attempt too much detail.

Other characteristics of the broad technical education might be specified, but we must pass on to consider what, by reasonable expectation, should be the *characteristics of the student, the graduate, the product.*

If we ask the officials of the schools, they would doubtless be nearly unanimous in claiming a rather good article. (Some years ago the recent graduates of a college of mechanical engineering were recommended to the U. S. government as competent to step in at once and operate the engines of the war vessels.) If we ask the young men themselves how they rate themselves —? Here General Horace Porter's advice to the cadets is apropos: Never under-rate yourself in action, nor over-rate yourself in a report.

"Men are born as ignorant as they ever were"; but, looking back forty years, we see vastly increased facilities for the earnest student of to-day: spacious and convenient buildings, well-equipped shops and laboratories and expansion of class-work and practise-courses. Also, in many institutions, the benefit of the advanced policy by which leading instructors are or have been practising engineers. Yet the conditions of the school must ever be artificial, at least in part, since they can not supply the acute sense of responsibility which goads a man on the works under an exacting chief.

What then are the practicable characteristics which we can specify for our graduate?

He may be a competent instrument man in all ordinary surveying operations, fitted to become a surveyor after due experience.

He may be a careful and accurate draftsman immediately available in the office, but not content to remain a mere draftsman many years.

If he is an exceptional man, with the right personal equation, he may be an acceptable inspector on works, but this usually requires some previous experience with men and affairs.

As a possible assistant to a city engineer he may have to act in either or all of these capacities during the first season.

He may be competent to take subordinate responsibilities as mechanical or electrical engineer or foreman.

In railroad work he must usually begin low down, but he is qualified to win rapid promotion.

Whether in these or other openings, if he is wise, he will consider himself only a beginner, an humble learner, ready to take lessons from foremen and laborers, on practical details. He will avoid manifesting self-conceit, and "*restrain* his little knowledge" until it is wanted; else he may get a snub from his chief which he will remember for a lifetime.

It is another platitude that many technical graduates find their way into other pursuits for which their studies have indirectly fitted them—such as contracting, executive positions, scientific agriculture, etc.; otherwise the number of institutions and graduates would be excessive. We may say, then, that *adaptation* often is and always should be a distinguishing characteristic of the competent graduate. At times when opportunities are not ready to hand, he ought to know how to "size up" the situation and go to work to make one. He may have to conduct a campaign, by interviewing, public speaking and writing, to educate possible clients or the public, as to the value or necessity of some public improvement or private enterprise. For the engineer always labors under the odium of one who spends other people's money. Happy is he if he is where such matters are decided upon their merits. Too often he will be opposed by political influence or private spite. He needs sound judgment, tact and determination to disarm opposition and push his work wisely.

Some months ago a graduate of eight years' standing wrote to the speaker that he was manager of water-works, etc., in a certain town in a state south of the Ohio; that he had made the surveys and estimates, organized the company, sold the stock, built a 25-million-gallon reservoir, with pumping station and electric lighting station as an adjunct, and had a $50,000 plant "running finely."

Our term "characteristic" indicates the most important quality of all—*character*. Some cynic has said that education is but a varnish or polish; "you silver scour a pewter dish, it will be pewter still." This half-truth is so far true that our human result must depend largely upon the antecedent conditions of inherited traits or disposition, and family training of the student. The constant action and reaction between student and instructors during four or five years has directed and controlled the professional growth. Given the right moral qualities in the man, there has been corresponding growth in character, producing integrity—wholeness. The nature and methods of engineering studies and practise promote this. In these threatening times of extravagance and corruption incorruptible honesty in purpose and action is urgently needed. If our graduate has courage to resist the tempter, even though he may lose present gain, he will

surely be in demand when men "find him out." If he has enough of the love of God he will have enough of the fear of God to put down the fear of man. Employers inquiring for graduates often say: "We don't care so much for great attainments or brilliant qualities; but we must have men whom we can absolutely trust."

In brief, the crowning characteristic is unqualified trustworthiness.

The level-headed graduate will not be misled by the familiar talk about "room at the top"; if he applies the theory of probabilities to himself he will correct that fallacy quickly. Few have their works known and seen of all men; most of us are "unpraised and unsung." But he will cherish the noble discontent which will ever spur him to high endeavor, and not permit him to cease from being a "growing man."

Rose Polytechnic Institute, through its able president and superior faculty, is working out the high ideals of its founder. It is showing its students that technical education is not the mere appropriation of a mass of information concerning theories, methods and results; but rather the selection of essential principles and data, and the coordination of these into a sequence of available knowledge. It reveals the accumulations of knowledge and teaches how and where to find what the man wants to know. Its practical instruction emphasizes and clinches correct theory, and makes not a present but a possible expert. It plants the germs, arouses the appetite, supplies the working principles, and teaches men to "think it out" for themselves; each graduate is a good deal of a scientist and something of an artisan, prepared to learn something about everything, and, if he lives long enough, to learn everything about something.

The greater results of the operations of nature's forces are accomplished by noiseless action, as with solar energy and many molecular transformations. James Watt, whose labors gave to the world all the potentialities of the steam engine, is said to have worked ever in quietness and contentment of spirit. *This higher institution*. this noble *instrumentality in the kingdom of God,* in the quietness of effectual working, has already sent forth an army of alumni. As another squad of well-drilled recruits goes forth to join the ranks (perhaps the spirit of the founder in some way observant) the "order of the day" displayed by alma mater is: Every man is expected to render full measure of duty and service, in doing the world's work in the fear of God.

ROBERT FLETCHER

DARTMOUTH COLLEGE

INTERNATIONAL EXCHANGE OF STUDENTS

AN influential committee has been formed in Great Britain to promote international exchange of students between the universities of Great Britain, Canada and the United States. Lord Strathcona is president of the committee and among the vice-presidents are Lord Curzon, chancellor of the University of Oxford; Mr. Balfour, chancellor of the University of Edinburgh; the prime minister, the lord chancellor and other distinguished men, including a large representation of professors from the British universities. Committees have not been yet organized in the United States and Canada, but leading educators have promised their cooperation.

It is proposed to establish two students' traveling bureaus, one in New York and one in London; an American secretary (resident in New York) and a British secretary (resident in London), both of whom shall be college men appointed to afford every facility to any graduate or undergraduate of any university who wishes to visit the United States, Canada or the United Kingdom for the purpose of obtaining an insight into the student, national and industrial life of those countries.

The bureaus will undertake the work of providing information relating to United States, Canadian, British and other English-speaking universities for the use of students, undergraduates and others. They will also provide information relating to educational tours of any description in English-speaking countries, and the arrangement of tours suitable to the needs of the inquirer with a view to his obtaining the greatest facilities for education with a *minimum* of expense. Furthermore it will be their duty to provide information as to the best places for the study of educational, governmental, industrial and social problems in the United States, Canada and the United Kingdom, and other parts of the empire, as well as to provide introductions to leaders in the above-named spheres of activity, besides undertaking the organization and conduct of special tours for educational purposes, if necessary.

It is proposed to provide 28 traveling scholarships, 14 of these being available for universities in the United Kingdom, 10 for universities in America and 4 for universities in Canada. The arrangements will be controlled by general committees, one for the United Kingdom and one for Canada and the United States, unless it is found necessary to inaugurate a separate committee for each of the latter.

THE WINNIPEG MEETING OF THE BRITISH ASSOCIATION

SOME further announcements have been made in regard to the seventy-ninth annual meeting of the British Association for the Advancement of Science, to be held at Winnipeg from August 25 to September 1.

The inaugural meeting will be held on Wednesday, August 25, at 8.30 P.M., when Professor Sir J. J. Thomson, Sc.D., D.Sc., F.R.S., assumes the presidency, in succession to Mr. Francis Darwin, M.A., M.B., LL.D., F.R.S., and will deliver an address. On Thursday, August 26, at 8.30 P.M., the first evening discourse will be delivered by A. E. H. Tutton, M.A., D.Sc., F.R.S., on "The Seven Styles of Crystal Architecture." On Tuesday, August 31, at 8.30 P.M., the second evening discourse will be delivered by Professor W. A. Herdman, D.Sc., F.R.S., on "Our Food from the Waters." Lectures to the citizens of Winnipeg will be delivered in the Walker Theater by Professor Harold B. Dixon, M.A., F.R.S., on "The Chemistry of Flame," on Monday evening, August 30; and by Professor J. H. Poynting, D.Sc., F.R.S., on "The Pressure of Light," on Wednesday evening, September 1. The concluding meeting will be held in the legislative chamber, Parliament Building, on Wednesday, September 1, at 3 P.M.

Garden parties will be arranged on several afternoons during the meeting, including those given at the historic Lower Fort Garry by the commissioner of the Hudson's Bay Company and at the Provincial Agricultural College. Evening receptions are intended to be held by the Lieutenant-Governor at Government House and by the local executive committee.

Excursions will be arranged on Saturday, August 28, to points of interest in the vicinity of Winnipeg, including Stony Mountain and the municipal stone quarries; Lake Winnipeg, St. Andrew's Rapids and Selkirk; the wheat fields of Manitoba; the hydro-electric plant on the Winnipeg River. Members will also have the opportunity of visiting the following works in the city of Winnipeg: Canadian Pacific Railway shops and yards, Canadian Northern Railway shops, Grand Trunk Pacific Railway shops (under construction), Ogilvie flour mills, western Canada flour mills, municipal high-pressure plant and artesian well system.

An excursion will be arranged for mineralogists and geologists to the Cobalt district before the meeting. Headquarters for visitors at Cobalt will be at the office of Mr. A. A. Cole, Mining Engineer of the Temiskaming and Northern Ontario Railway and a program will be arranged for August 17 and 18. A visit to Sudbury is also contemplated after that to Cobalt. Further information may be obtained from Professor W. G. Miller, pro-

vincial geologist, Bureau of Mines, Toronto, Ontario; or from Mr. Cole.

An excursion of ten days after the meeting to the Rocky Mountains and the Pacific Coast is contemplated. Accommodation in the special train will be limited to 150 invited members, including 25 ladies.

Those proposing to attend the Winnipeg meeting can obtain from any railway ticket agent in eastern or western Canada a standard convention certificate which when properly validated in Winnipeg will enable them to return over the same route to the initial starting point without charge. Such certificates will be sold from August 16 to August 23 and will be valid for return until October 31. The fare from Quebec or Montreal to Winnipeg is $36.

It will be remembered that members of the American Association for the Advancement of Science will be admitted as full members of the British Association, for the Winnipeg meeting (and entitled to receive the volume of Proceedings), on payment of a fee of $5 (half the regular fee). It is important that those intending to be present should send in their names as soon as possible; printed matter bearing on the meeting will be gladly furnished by the local secretaries, the University of Manitoba, Winnipeg.

THE DARWIN CENTENARY AT CAMBRIDGE

THE program of the commemoration began on the evening of June 22, when Lord Rayleigh, the chancellor of the university, welcomed to Cambridge the delegates, of whom there were two hundred and fifty, including thirty from the United States. On the following day addresses were presented by the delegates and speeches were made by the chancellor, Professor Hertwig, Professor Metchnikoff, Dr. Osborn and Sir E. Ray Lankester. In the afternoon there was a garden party at Christ's College, where Darwin was a student. There had been arranged there an extensive exhibition of portraits, manuscripts and other objects. To Christ's College the American delegates presented a bronze replica of the bust of Darwin by Mr. Couper, presented by the New York Academy of Sciences to the American Museum of Natural History. In the evening there was a dinner with addresses by Mr. Balfour and Professor Poulton. This was followed by a reception at Pembroke College. On Thursday honorary degrees were conferred on twenty-one delegates whose names have already been printed in SCIENCE and Sir Archibald Geikie, president of the Royal Society, gave the Rede lecture on Darwin as a geologist. In the afternoon there was a garden party at Trinity College given by members of the Darwin family.

SCIENTIFIC NOTES AND NEWS

SIMON NEWCOMB, the great astronomer, born in Wallace, Nova Scotia, on March 12, 1835, died from cancer at his home in Washington in the early morning of July 11.

AMONG the honors awarded on the birthday of King Edward are knighthoods to Mr. Francis Galton, Professor J. Larmor, Mr. R. H. I. Palgrave and Professor T. E. Thorpe. Sir Dyce Duckworth and Mr. Henry Morris, president of the Royal College of Surgeons, received baronetcies; Dr. W. Schlich was appointed a Knight Commander of the Order of the Indian Empire (K.C.I.E.) and Mr. James Stuart has been made a privy councillor.

THE University of Manchester has conferred its doctorate of science on Professor Theodore W. Richards, professor of chemistry at Harvard; Dr. Otto Wallach, professor of organic chemistry at Göttingen, and Professor Henry E. Armstrong, professor of chemistry in the City and Guilds of London Technical Institute.

IN connection with the Darwin centenary celebrations Mr. Francis Darwin has been elected a foreign member of La Société Hollandaise des Sciences, Harlem, and a member of the American Philosophical Society, and Professor Sir George Darwin and Mr. Francis Darwin have been elected corresponding members of the Senckenbergische Naturforschende Gesellschaft, Frankfort, honorary members

of the Imperial Moscow Society of Naturalists, honorary members of the University of Moscow and members of the Kaiserliche Leopoldinisch-Carolinische Deutsche Akademie, Halle. The last-named academy was the first of foreign academies to honor Charles Darwin by making him a member in the year 1857. He was also a member of the Harlem, Philadelphia, Frankfort, Moscow and Halle Societies.

ON the occasion of the opening of the new surgical block of the Glasgow Royal Infirmary on June 23, a medallion portrait in bronze of Lord Lister was presented by the past and present members of the staff. The medallion is fixed on the wall opposite the entrance hall of the new block. The inscription on the framework records that Lord Lister was one of the surgeons of the Royal Infirmary from 1861 till 1869, and that in that institution he organized the antiseptic system of surgical treatment.

AT the meeting of the Physiological Society held at Oxford on June 26 Professor Gotch, who presided on the occasion, after a sympathetic speech, presented to Dr. Pavy, in commemoration of the eightieth anniversary of his birth, a silver bowl bearing the following inscription: "Frederick William Pavy, M.D., F.R.S., May 29th, 1909. From the Physiological Society, in token of affection and admiration."

A PAINTING by Mr. W. S. Kendall of Dr. T. M. Prudden, professor of pathology in Columbia University from 1882 to 1909, now emeritus professor, has been presented to the university by colleagues, students and other friends.

DR. J. MARK BALDWIN, professor of philosophy and psychology in the Johns Hopkins University, has resigned. Professor Baldwin has been attending the Darwin centenary at Cambridge, as the representative of the Johns Hopkins University and the Mexican Department of Public Instruction, and expects to remain abroad for some time.

MR. F. H. SEARES has resigned the position of professor of astronomy and director of the Laws Observatory of the University of Missouri. On August 1 he will become superintendent of the computing division of the Mount Wilson Solar Observatory of the Carnegie Institution.

DR. ALONZO S. MCDANIEL, who took the Ph.D. degree with physical chemistry as his major subject at Wisconsin last June, has been appointed chemist at the Bureau of Standards, Washington, D. C.

DR. MAZYCK P. RAVENEL, director of the State Hygienic Laboratory, Madison, will be placed at the head of the Wisconsin Pasteur Institute recently established in connection with the state laboratory.

MR. SINCLAIR WHITE, senior surgeon to the Royal Infirmary at Sheffield, has been elected president of the British Medical Association, to fill the vacancy caused by the death of Mr. Simeon Snell.

PROFESSOR ALBERT LADENBURG, director of the chemical laboratories at Breslau and known for his work in organic chemistry, is about to retire from active service.

DR. PAUL ASCHERSON, professor at Berlin, and eminent for his work on the geographical distribution of plants, has celebrated his seventy-first birthday.

DR. REID HUNT has gone abroad to attend, as representative of the Public Health Service, the International Congress on Alcoholism, London, July 18, and the International Medical Congress, Budapest, August 28.

DR. SPENCER TROTTER, professor of biology at Swarthmore College, has been granted leave of absence for the coming year. Dr. Trotter will study in the museums in Germany and France, and in the marine laboratories on the Mediterranean. Mr. Samuel Copeland Palmer, who has spent two years in the graduate school of Harvard University, will be acting professor of biology.

DR. JOHN A. MILLER, professor of mathematics and astronomy at Swarthmore College, is spending the summer at the Lick Observatory, measuring the photographs of the solar corona at that place. The new photographic telescope of nine inches aperture, the first

part of the astronomical equipment given to Swarthmore by Senator William C. Sproul, was installed this year in the new observatory provided for it. The observatory of Dorpat, Russia, has requested copies of the photographs of the Morehouse Comet, made on October 14, 15, 16 and 17, at the Sproul Observatory, Swarthmore College. These photographs will be published in the proceedings of the Russian observatory.

THE sum of $8,000 required to purchase the home for the widow and children of the late Major Carroll has now been subscribed. The subscriptions came mainly from medical officers of the army and the Marine Hospital Service and from physicians.

PROFESSOR J. D. CUNNINGHAM, of the University of Edinburgh, eminent for his services to anatomy, has died at the age of fifty-nine years.

DR. WILHELM ZOPF, professor of botany at Münster, has died at the age of sixty-two years.

THE deaths are also announced of Mr. G. F. Beacon, a distinguished British civil engineer, and of Dr. Wilhelm Müller, professor of pathological anatomy at Jena.

THE Congress has appropriated the sum of $25,000 for the expenses of the Congress of Hygiene and Demography, which is to be held in Washington next year.

A JOINT meeting of the International Scientific Association of Colonial Agriculture of Paris and the Society of Tropical Studies of Brussels, will take place in Paris on July 9, to make arrangements for holding the International Congress of Tropical and Colonial Planters and Experts interested in tropical agriculture, which will take place in Brussels in May, 1910.

THE Gamma chapter of the honorary fraternity of Phi Lambda Upsilon has been established at Columbia. Membership is limited to chemists and chemical engineers in the faculty, graduates and advanced students.

THE following addresses have been delivered at the regular monthly meetings of the Oregon Academy of Sciences: April meeting, "Cremation *vs.* Earth Burial," by Colonel A. W. Miller; May meeting, "Douglas Fir," by Dr. J. R. Cardwell; June meeting, "Alaska during the Klondike Rush," by Albert M. Grilley, illustrated by stereoptican views.

THE wall maps, atlases and text-books, representative of many of the best appliances used for geographical education in Europe, which were collected last year by the American Geographical Society, are now on exhibition in the university summer schools of the middle west. The exhibition opened at the University of Wisconsin on April 15, at the University of Minnesota on June 4 and at the Ohio State University on June 21. The later exhibitions will open at the University of Chicago, June 15; Denison University, Granville, Ohio, September 15; University of Cincinnati, October 15; State Normal School of Michigan, Ypsilanti, November 24, and the University of Michigan, December 1. The University of California and Leland Stanford Junior University have secured the collection for dates not yet assigned and when it goes to the Pacific coast it will probably remain there for some time. Not a few teachers think that the collection will be especially helpful in the normal schools and it is expected that many of them will exhibit it. The material is loaned to any educational institution that desires it.

AT a recent meeting of the County Schools Commissioners of Georgia, in convention at Tallulah Falls, June 29 and 30 and July 1, the subject of birds in their relation to agriculture was discussed, and it was decided to introduce the subject as a study into the common schools of the state. Professor R. J. H. DeLoach, of the University of Georgia College of Agriculture, was asked by the convention to prepare a bulletin on the subject, which is to be published by the state school commissioner and distributed, free of charge, to all school teachers in the state. Georgia is rich in bird life, both in summer and winter, and the teachers will be able with proper guidance to greatly strengthen the fight for bird protection in the state.

A FORESTRY survey of the State of Illinois is now in progress under the joint auspices of the Illinois State Laboratory of Natural His-

tory and the United States Forest Service, which share equally in the expenses of the work. Engagements have been entered into which will bring the survey to a completion in 1910. Maps will be published showing the present and original distribution of forest areas in Illinois, and a report will be made, by counties, in detail, together with a description of the various types of forest, as to composition and condition, estimates of the standing timber in each county, means of maintaining the producing power of the forest lands of the state, and recommendations to private owners for the handling of their lands in a way to maintain and improve their forests.

An Alabama Anthropological Society has been established. It is composed of twelve active members, residents of Montgomery, and of such associate and honorary members (an unlimited number) as may be hereafter elected. There are to be 12 meetings each year, each member submitting one paper. It is planned to issue from time to time publications of a scientific nature and a yearly bulletin containing the twelve papers submitted during the year. The first regular meeting will take place on July 22. The officers are: Thomas M. Owen, LL.D., president; Herbert B. Battle, Ph.D., vice-president; Peter A. Brannon, secretary; Buckner Beasley, treasurer.

UNIVERSITY AND EDUCATIONAL NEWS

Mr. John D. Rockefeller has made a further gift of $10,000,000 to the General Education Board. Its endowment is now $53,000,000. Mr. Rockefeller has authorized the board to distribute the principal as well as the income for educational purposes should this at any future time appear to be advisable.

Union College has received $75,000 from Mrs. Katherine Spencer Leavitt, of Washington, for the endowment of the department of philosophy, the gift being in memory of her father, Rev. Dr. Spencer, of Brooklyn, N. Y., who was graduated from Union in 1824.

Lord Strathcona, Canadian high commissioner in London, has given half a million dollars to McGill University. Of this amount, $450,000 is to be used for completing the new medical building, and the balance for the augmentation of salaries of the faculty.

Messrs. John Swire and Sons have promised a contribution of £30,000 towards the Hong Kong University endowment fund, the Taikoo Sugar Refining Company £5,000 and the Ocean Steamship Company £5,000, on condition that the whole amount required is subscribed.

The University of Liverpool announces that the J. W. Garrett international fellowship in pathology and physiology of the value of £100 per annum, open to members of universities and medical schools in the United States, will be awarded in September. Applications should be addressed to the dean of the medical faculty, University of Liverpool.

Dr. Milton J. Rosenau, director of the hygienic laboratories of the Public Health and Marine Hospital Service, has been appointed head of a newly established department of hygiene and preventive medicine in the Harvard Medical School.

Professor Julius Stieglitz, of the department of chemistry of the University of Chicago, has recently been made director of the laboratories of analytical chemistry in that institution.

Students who have been engaged in research work in the laboratory of physiological chemistry of Yale University and have received the degree of doctor of philosophy from the institution, have received appointments as follows: John Franklin Lyman, assistant professor agricultural chemistry, Ohio State University; Mary Davies Swartz, instructor in Teachers College, Columbia University; Israel S. Kleiner, demonstrator of physiological chemistry, medical department, of Tulane University; Warren W. Hilditch, instructor in physiological chemistry, Syracuse University; Victor C. Myers, adjunct professor of physiological chemistry, Albany Medical College; Arthur W. Dox, chemist, cheese investigations, Storrs Agricultural Experiment Station.

to ascribe to the velocity of light this unique position. Nature forces us to a conclusion and if this conclusion is incompatible with our preconceived opinions, it is the opinions that must be changed.

Not many years ago, it was supposed to be possible to increase both heat and cold without limit, but we no longer hope to attain any temperature below $-273°$ C. To cool any body to the absolute zero would require an infinite amount of work. Now we find likewise that it would take infinite work to bring any body to the velocity of light, and just as $-273°$ C. became recognized first as the lowest possible temperature, then as the lowest conceivable temperature, so we must not only regard 3×10^{10} centimenters per second as the highest possible velocity, but we must so change our present ideas that this shall be the ***highest conceivable velocity*** in a material system.

In closing I should like to modify one of the statements in my previous paper. It was there intimated that the equations of non-Newtonian mechanics offered a means of determining absolute motion through space. In a recent paper by Mr. Tolman and myself[8] it is shown, on the other hand, that these equations maintain their full validity no matter what point is arbitrarily chosen as a point of rest.

Gilbert N. Lewis

Research Laboratory of Physical Chemistry,
Massachusetts Institute of Technology,
June 19, 1909

[8] "The Principle of Relativity and Non-Newtonian Mechanics," *Proc. Amer. Acad.*, June, 1909.

SOME TRENDS IN HIGHER EDUCATION

To the Editor of Science: I was very much interested in the article by Mr. Marx entitled "Some Trends in Higher Education," which appeared in the issue of Science of May 14. While I believe that such investigations are of value, it seems to me that this article and others of a like nature, which have been appearing recently, show the need for more accurate and reliable statistics relating to higher education. In the great majority of cases the writers have all too often been intimately acquainted with only one institution. They have realized that in the case of this institution, well known to them, allowance had to be made for the published statistics, but they have not shown equal generosity to those institutions concerning which they knew little or nothing, and have accepted all statistics at face value. All persons connected with universities know very well, for example, how little trust is to be placed in the average comparative tables regarding the total number of students at the various institutions of learning. Nearly every larger university, by means of due selection and suppression, has made out a good case at one time or another in the attempt to show that it is the largest university in this country. These methods savor very much of some of the advertising indulged in by insurance companies, but universities and those writing about them ought to have a somewhat more scientific standard.

Mr. Marx's article is not devoid of many of the faults to which I have alluded. To cite just one instance: take, for example, the last column of table 4 on page 784. This table is supposed to give the average salary per member of the instruction staff, but surely no one having an intelligent knowledge of higher education in America can suppose that the *average* salary per year at Johns Hopkins is $1,226, or at Northwestern $835, or at Minnesota $867, or at Toronto $881.

It is not surprising to find the most erroneous conceptions prevailing about the administration of our universities, when even a responsible paper like Science publishes figures such as these noted without further explanation. Such looseness of statement does great injustice to many an institution. In the College of Liberal Arts at Northwestern University, where the salaries average lower than they do in the professional schools of the same institution, the instruction staff consists of fifty-nine persons. Their salaries for the year 1909–10 will amount to $117,450. This is an average annual salary of almost $2,000 per individual. It is a fact that no teacher in the university, who is paid at all, receives for a year's work so small a sum as $835. The low-

est salaries paid are, I believe, $900 to one man, and $1,000 to several others.

How then could such an average as $835 be obtained at all? The explanation is simple. Northwestern University Medical School, by reason of its situation in the city of Chicago and in a section of the city where clinical material is very abundant, has a very large attendance, and the number of clinical professors, instructors, etc., is correspondingly large. According to what is almost the unbroken custom in this country, clinical instructors serve without pay, but since their income is not derived from the university at all, to count them in in computing an average salary is certainly a grave error.

I could show, I think, without much difficulty, that the statistics given for Harvard and several other of the institutions mentioned in the article in question are also entirely misleading without such explanations as Mr. Marx has seen proper to give in the case of the institution with which he happens to be connected.

In closing may I also protest against the slurring remark made about Temple College on page 784? I have never been connected in any shape, form or manner with this institution, nor have I had any friend who has been in attendance there. Still, I feel that it is no more than fair to inform Mr. Marx that this institution, situated in Philadelphia, is doing a very worthy work and certainly ought not to be referred to in the manner in which it was in the article in question.

WALTER LICHTENSTEIN
NORTHWESTERN UNIVERSITY LIBRARY

TO THE EDITOR OF SCIENCE: I have read Mr. Lichtenstein's letter with much interest and am grateful for the opportunity you so kindly offer me to comment on it. While my first feeling is that your correspondent's letter answers itself, the casual reader might draw the inference from silence on my part that the criticisms offered are sound and unanswerable.

The letter says: "Mr. Marx's article is not devoid of many of the faults to which I have alluded." Let us see what these enumerated faults are:

1. "This article and others of a like nature, which have been appearing recently, show the need for more accurate and reliable statistics relating to higher education." True. The writer would call attention to statements to this effect on page 783, column two, paragraph two; the last paragraph of page 784; and the latter part of column one and top of column two, page 787, of the original article.

If, however, the inference is meant to be drawn that the writer's data are inaccurate, he must beg for more specific criticism as he is prepared to demonstrate the indubitable authenticity of his data. To give the entire tabular data on which the charts are based and the authority for each item would require nearly as much space, however, as the original paper occupied. The sources include long series of annual catalogues, reports of presidents and treasurers, as well as personal communications from administrative officers. The same mail which brought the letter of your correspondent this morning, also brought one from the president of one of the large universities, who has known of this investigation for a year and a half and to whom the writer is indebted for valuable data, containing these words:

> Unfortunately a great majority of the articles on education are full of generalities based upon no special investigation, which really give no help to any one. In contrast with this you have carried on a very important comparative investigation in reference to facts as to actual tendencies.

Quotations in the same vein might be made from half a hundred letters received from similar authoritative sources. The men best acquainted with the facts best recognize the authenticity of the data compiled by the writer.

2. "In the great majority of the cases the writers have all too often been intimately acquainted with only one institution."

Is this one of the faults laid at Mr. Marx's door? If so, on what knowledge of facts is it based? The writer had the honor of contributing to the discussion of "The Condi-

tion and Needs of the University of California,"[1] and of preparing the "Report of the Committee on Salaries at Cornell."[2] These papers his critic may have seen, but what can he know of the writer's mass of correspondence and unpublished data, or of the duration and extent of his investigations?

3. "They have realized that in the case of this institution, well known to them, allowance had to be made for the published statistics, but they have not shown equal generosity to those institutions concerning which they knew little or nothing, and have accepted all statistics at face value." This broad charge very obviously refers to the writer's footnotes on page 784; but by what stretch of the imagination can these be interpreted as showing "generosity" to the institution he serves—figures which reduce the salary expenditure per student from $219 to $176.51, and the salary average from $2,500 to $1,500? These were obvious notes from other published data and the references were given.

4. "All persons connected with universities know very well for example, how little trust is to be placed in the average comparative tables regarding the total number of students at the various institutions of learning. Nearly every large university, by means of due selection and suppression, has made out a good case at one time or another in the attempt to show that it is the largest university in this country. These methods savor very much of some of the advertising indulged in by insurance companies, but universities and those writing about them ought to have a somewhat more scientific standard." So? Our critic "has a good eye. He can see a church by daylight." Specifically this can only refer to Table 4, page 784, a table compiled from data furnished, it is to be presumed, by the institutions themselves to the Carnegie Foundation and in the construction of which the writer's part was purely mechanical—dividing figures in one column by figures in another. He didn't even use his head for the purpose—he did it with a slide-rule. If the results of these divisions are not exactly what had been foreseen by those who furnished the data, the blame must not fall on the writer. If there is fraud by all means let it be weeded out. The plain truth is what we are after. If "such looseness of statement does great injustice to many an institution," *whose looseness of statement is it?* If "no one having an intelligent knowledge of higher education in America can suppose that the *average* salary per year at Johns Hopkins is $1,226, or at Northwestern $835, or at Minnesota $867, or at Toronto $881," then that person, if of average intelligence, must infer that the figures furnished by these institutions to the Carnegie Foundation lacked that element of accuracy and coherence which one might have a right to expect in data emanating from such sources.

[1] *Trans. Commonwealth Club of Cal.*, October, 1907.

[2] *Cornell Alumni News*, May 6, 1908.

Your correspondent intimates that he could show the Harvard statistics to be entirely misleading. In this case the sources of my data are so readily accessible to all that I will give them:

Chart 3. Data 1880–1904, President Eliot's Annual Report, 1904–5, p. 15. Additional points for 1876, 1905 and 1906 from catalogues.

Chart 8. Same report, pp. 18–19.

Chart 13. Same report, p. 15.

Charts 22 and 27. Data for 1904, same report, p. 345. (The average salary is there given as $1,570.) Data for 1907, Carnegie Foundation Bulletin No. 2, pp. 10–11. The only other Harvard statistics in the article are those of Table 4, p. 784, also from the Carnegie Bulletin, No. 2, pp. 10–11.

Where are these items at fault?

But this letter grows too long. Mr. Lichtenstein says the average salary computed for Northwestern is wrong because it includes men who get *nothing at all* for their services. Under the circumstances the argument is naïve. It reminds one of Sheridan's consoling remark to his very stout but rueful adversary in a duel: "To even things up we will draw two chalk-lines down you and

all my shots which hit outside them we sha'n't count." If we eliminate those who teach for nothing at all, why not disregard those who get less than a specified sum, say $1,500? It would make a still more favorable showing for the average. The writer must confess inability to follow his critic's logic in this.

The writer has no prejudice against Temple College. It may be doing the worthy work your correspondent vouches for. The writer's passing curiosity was aroused by the fact that it appears to provide for the needs of 2,343 students, and a teaching staff of 198, out of an entire annual expenditure of $72,895, and so he gave voice to it. When all the facts are known, it is quite possible that this institution may be found to have sounder standards than many another guilty of extravagant and ostentatious expenditures. The more light we can get on these points the better.

After all, your correspondent and the writer don't disagree on the main point at issue, namely, that honest and reliable statistics are vitally necessary. Only, the writer was laboring under the impression that, so far as concerned data not previously common property, he was supplying to a slight extent just that kind of accurate material. Assuredly he has made effort enough to have it so; his conscience acquits him on that score. And it will take rather more convincing proof than that offered by this correspondent to shake his faith in its value.

GUIDO H. MARX

WARNING TO ZOOLOGISTS AND OTHERS

ZOOLOGISTS and geologists generally are warned that a clever swindler is making a canvass of the zoologists of New York, seeking money under false pretenses. He operates by claiming to be the "nephew" of some well-known scientist who is a personal friend of the intended victim; and the skill and thoroughness with which he prepares each case is fairly amazing. He knows thoroughly the scientific men of Washington, and especially those of the National Museum and the Cosmos Club.

In person he is tall (about 5 feet 10 inches), neatly and cleanly dressed, smoothly shaven and weighs about 170 pounds. He can instantly be recognized by his broad, flat face, small shifty eyes set widely apart, wide mouth, flabby lips and a long conspicuous row of upper teeth, all of them very evenly discolored by tobacco. When attempting to work his game, he laughs nervously fully half the time that he is talking.

If any intended victim of this man will hand him over to a policeman, I will very willingly arrange for witnesses to appear against him, for the purpose of landing him where he belongs.

W. T. HORNADAY

NEW YORK ZOOLOGICAL PARK,
July 8, 1909

WE have also received the following statement from the secretary of the Smithsonian Institution: A man familiar with scientific men of Washington and New York, claiming to be a nephew of the secretary of the Smithsonian Institution, has recently been securing money as a personal loan from friends of the secretary upon false pretenses. The secretary has no such nephew; the man is a swindler. He may be described as follows: Tall and large, weight about 165 pounds; Eskimo-like face, smoothly shaven; mouth, wide; lips, flabby; long conspicuous row of upper teeth evenly discolored by tobacco; age about 35; carries head inclined to the right; laughs almost constantly while talking.

SCIENTIFIC BOOKS

Ethics. By JOHN DEWEY and JAMES H. TUFTS. New York, Henry Holt and Co. Pp. xiii + 618.

Characteristic phases of ethical study during the last twenty-five years are the interest shown in the history of morality and the attention given to social, economic and political questions. The works of Letourneau, Sutherland, Westermarck and Hobhouse are able examples of the fruitfulness of the genetic method in ethical science, while the books of Wundt, Paulsen and Bergemann combine with the historical and theoretical treatment a discussion of the larger social problems that are agitating the civilized peoples of to-day.

A noteworthy addition to this latter group of books on ethics is the volume written by Professors Dewey and Tufts. In its first part it examines the beginnings and growth of morality, describing certain aspects of group life and tracing the process of moral development in its general outlines, ending with specific illustrations of the process taken from the life of Israel, Greece and modern civilization. Part II., which represents Professor Dewey's contribution to the book, analyzes conduct on the inner personal side. It seeks to find the meaning of moral action (The Moral Situation, Problems of Moral Theory), discusses the typical answers which have been made to this question (Types of Moral Theory), tries to discover the principles underlying moral judgments and moral conduct (Conduct and Character, Happiness and Conduct, Happiness and Social Ends, Place of Reason in the Moral Life, Place of Duty in the Moral Life, Place of Self in the Moral Life), and ends with an examination of the fundamental virtues. Part III. is entitled The World of Action and studies conduct as action in society. The attention is here centered upon three phases of conduct which are of especial interest and importance: political rights and duties, the production, distribution and ownership of wealth, and the relations of domestic and family life (Social Organization and the Individual, Civil Society and the Political State, The Ethics of the Economic Life, Some Principles in the Economic Order, Unsettled Problems in the Economic Order, The Family).

The plan of the book is good. It is important that the student be made acquainted with the facts of moral life, with the moral ideas and practises of the race in their evolution, that he study the principles of morality, and finally that he receive some guidance in the application of this knowledge to the problems of individual and social life. It is not easy, however, to carry out so comprehensive a plan within the narrow limits of a single text-book. There is little wonder therefore that the reader should at times wish for a somewhat fuller treatment; so much matter is often compressed into a narrow compass that only a student already familiar with the subject can thoroughly appreciate it. This is particularly true of the chapter on the Hebrew Moral Development and the chapter on the Virtues. But as the bibliographies given at the end of each chapter are excellent, no person possessed of the reading habit need remain in darkness.

Another characteristic of modern ethics is its desire to do justice to the different ethical theories and movements which have divided thought and practice. In this respect too the book before us exemplifies the spirit of the times. Assuming as it does that there is some germ of truth in each one of the great schools, it seeks to make peace between them, choosing sanely that which is valuable in each. Thus in the consideration of the controversy between the "attitude theory" and the "result theory" the conclusion is reached that it is an error to split a voluntary act which is single and entire into two unrelated parts, "inner" and "outer," "motive" and "end." A "mere" motive which does not do anything, which makes nothing different, is not a genuine motive at all, and hence is not a voluntary act. Consequences which are not intended, which are not personally wanted and chosen and striven for, are no part of a voluntary act (p. 238). And as only voluntary acts are morally judged, "the appropriate subject-matter of moral judgment is the disposition of the person as manifested in the tendencies which cause certain consequences, rather than others, to be considered and esteemed—foreseen and desired. Disposition, motive, intent are then judged good or bad according to the consequences they tend to produce" (p. 262).

This would seem to be the correct solution of the conflict between the Kantians and the Utilitarians on this point. The question as to the *nature* of these consequences is handled in the same impartial way; we get another searching analysis of Utilitarianism and the opposing views, and an excellent criticism of psychological hedonism (chapters XIV., XV.). The net result of the discussion is:

(1) That happiness consists in the fulfillment in their appropriate objects (or the anticipation of such fulfillment) of the powers of the self manifested in desire, purposes, efforts; (2) true happiness consists in the satisfaction of those powers of the self which are of higher quality; (3) that the man of good character, the one in whom these powers are already active, is the judge, in the concrete, of happiness and misery (p. 280).

This view avoids the exaggerations of both hedonism and perfectionism; it shows also the influence of Professor Dewey's earlier idealistic training. But another question comes up here, and that is the time-honored controversy between individualism and universalism. And here too later Utilitarianism and German idealism join hands.

The genuinely moral person is one in whom the habit of regarding all capacities and habits of the self from the social standpoint is formed and active. Such an one forms his plans, regulates his desires, and hence performs his acts with reference to the effect they have upon the social groups of which he is a part (p. 298).

The true or final happiness of an individual lies not in the objective achievement of results, but in the supremacy within the character of an alert, sincere and persistent interest in those habits and institutions which forward common ends among men (p. 301).

Regard for the happiness of others means *regard for those conditions and objects which permit others freely to exercise their own powers from their own initiative, reflection and choice* (p. 302).

Moral worth consists in a readiness to regard the general happiness even against contrary promptings of personal comfort and gain (p. 364). This idea of the place of the self in the moral life is worked out in an interesting chapter XVIII., which discusses Self-Denial, Self-Assertion, Self-Love and Benevolence, and the Good as Self-Realization. The final word is that

The problem of morality is the formation, out of the body of original instinctive impulses which compose the natural self, of a voluntary self in which socialized desires and affections are dominant, and in which the last and controlling principle of deliberation is the love of the objects which will make this transformation possible. If we identify, as we must do, the interests of such a character with the virtues, we may say with Spinoza that happiness is not the reward of virtue, but is virtue itself (p. 397).

Morality, then, consists in the social attitude; the highest type of moral men consciously aim at the social good. This type is, according to Professor Tufts, the product of moral evolution; on the third level of conduct, the level of conscience, conduct is regulated by a standard which is both social and rational, and which is examined and criticized (p. 38). It is the stage of complete morality, which is reached "only when the individual recognizes the right or chooses the good freely, devotes himself heartily to its fulfillment, and seeks a progressive social development in which every member of society shall share" (p. 73). And

It is as true of progressive society as of stationary society, that the moral and the social are one. The virtues of the individual in a progressive society are more reflective, more critical, involve more exercise of comparison and selection, than in customary society. But they are just as socially conditioned in their origin and as socially directed in their manifestation (pp. 434 f.).

And it is this social standard that Professor Tufts applies in his sane discussions of the social, economic, political and domestic problems to which the last third of the book is devoted.

Persons of individualistic temperament will feel that the social element is somewhat exaggerated in these accounts. They may grant that the moral is the social in the sense that moral acts have to do with the ordering of social relations. And they may grant that the agent is moral when he strives for the social weal. But it may be questioned whether the social motive is the only moral motive, whether acts prompted by the sense of obligation or the love of virtue are non-moral. At the same time the rules of morality are largely social in their origin and purpose, and the social ideal is the guiding principle of moral evolution.

The book is a valuable addition to the many

able works on ethics that have been published in recent years and it is a credit to American scholarship.

FRANK THILLY

CORNELL UNIVERSITY

Athletic Games in the Education of Women. By GERTRUDE DUDLEY, Director of the Women's Department of Physical Education, University of Chicago, and FRANCES A. KELLOR, author of "Experimental Sociology," "Out of Work," etc. New York, Henry Holt & Co. Price $1.25 net.

Miss Dudley and Miss Kellor have presented a study which is unique, not only with reference to the influence of athletic sports and particularly team games upon women, but with reference to the nature and meaning of athletic sports themselves. The titles of the first three chapters are significant of this fact. They are: Citizenship and Social Education, Educational Value of Athletics, Instructors—their Responsibility and Training.

The plan of the book, after presenting these general sociological and pedagogical considerations, involves a discussion of athletics for girls as now carried on in secondary schools, colleges, universities and clubs. It involves also a discussion of the nature and effects of competition, and particularly of competition in public. The influence of games in promoting self-control, cooperation, fair play, loyalty, courage, responsibility, discipline, is discussed. The book takes up the matter of training in general and training specifically for basket ball, field hockey, etc.

The philosophical point of view taken is that the instinct feelings back of athletics are in the main those that make and control masculine character; that the ability to do team work is developed in the male by playing team games, such as baseball; and that modern woman, in her growing relationship to the community has need of these same elements of capacity for subordinating the self to the whole, of "playing the game," that a man gets through his athletics. The authors add: "These qualities are not essentially masculine. They are but human qualities, needed for human fellowship." There is frank recognition of the fact that the ethical element is secured only when the games are wisely conducted, and that too often only evil results are secured from badly managed athletics.

A question is raised in the mind of the reviewer as to the truth of the first assumption. Is woman really changing her relation to society? Is the present world-wide wave of unrest among women symptomatic of a permanent biological or sociological readjustment; and if such is the case, is the readjustment to come about through the social discipline of the female, by the same means through which the male has been disciplined? Are the social instinct feelings which have been so closely connected with woman's life—as far back as the ages of savagery—to be changed and developed into instinct feelings that tend toward the team spirit? The query is raised, but in the nature of the case it can not perhaps be answered, for it is easier to look back than to look forward.

LUTHER HALSEY GULICK

NEW YORK,
June 15, 1909

FISHES OF THE RUSSIAN EMPIRE AND OF AFRICA

A MUCH-NEEDED "Preliminary Synopsis of the Fishes of the Russian Empire" from a systematic and geographical point of view has been published by V. I. Gratzianow. It is dated on the title page, Moscow, 1907, but the copy in the Smithsonian Library was received April 3, 1909. The work is entirely in Russian and consequently will be of little use to most ichthyologists except for what may be gathered from the scientific names. The classification of Jordan is adopted mainly. 948 species are enumerated under 331 genera and 101 families. Dichotomous tables are given for the various groups.

The first volume of a "Catalogue of the Fresh-water Fishes of Africa in the British Museum (Natural History)," by George Albert Boulenger, has been published by the museum. It embraces the Selachians and the Teleostomes down to and including the Cyprinoid genera *Labeo, Discognathus* and *Varicorhinus*. Descriptions of all the species

and figures of almost all (270) are given. It is expected that the work will be completed in three volumes. An extended notice may be expected on the completion.

THEO. GILL

SCIENTIFIC JOURNALS AND ARTICLES

The Journal of Experimental Zoology, Vol. VI., No. 3 (June, 1909) contains the following articles: "Studies on the Physiology of Reproduction in the Domestic Fowl—I., Regulation in the Morphogenetic Activity of the Oviduct," by Raymond Pearl. This paper describes a case in which a regulatory change in the shape of eggs successively laid by the same hen occurred, the change in shape following a logarithmic law. "The Physiology of Nematocysts," by O. C. Glaser and C. M. Sparrow. Experiments made on living nematocyst-bearing tissues as well as on artificially isolated nettling organs show that a rise in internal pressure brings about the discharge of the stinging thread; that osmotic pressure is responsible for the explosions of nematocysts in Eolids; that this may explain the similar processes among Cœlenterates; and finally that the nettling threads, contrary opinions notwithstanding, are capable of penetrating the tissues of other animals. "Observations on the Life History of *Tillina magna*," by L. H. Gregory. A study of the morphology, physiology and methods of reproduction of the organisms, and its reactions to stimulations during different periods in the life history, with especial reference to the questions of artificial rejuvenescence and the inter-relations of nucleus and cytoplasm. "Studies of Tissue Growth—II., Functional Activity, Form Regulation, Level of the Cut and Degree of Injury as Factors in Determining the Rate of Regeneration—The Reaction of Regenerating Tissue on the Old Body," by Charles R. Stockard. The rate of regeneration in the medusa, *Cassiopea*, is independent of functional activity; form regulation inhibits growth; and the level of the cut determines the rate of regeneration in many species. The degree of injury does not exert the same influence over the rate of regeneration in all species; the new tissue has an excessive capacity for the absorption of nutriment even to the detriment of the old body.

SPECIAL ARTICLES

ON THE RESTORATION OF SKELETONS OF FOSSIL VERTEBRATES

IN a paper published last October[1] the writer, in referring to the mounted carnivorous dinosaur in the American Museum of Natural History supposed to be *Allosaurus* or *Creosaurus*, compared its hands with those of Marsh's restoration of *Allosaurus*. Inasmuch as the hands of the New York specimen are wholly artificial and those of Marsh's figure mostly or wholly so, it will be seen that the comparison was of something less than no value at all. A serious error on the part of the writer must therefore be confessed. How it came to be committed will probably be of interest to nobody.

Although the quite complete hind leg of *Allosaurus* on which Marsh based his restoration[2] is in the U. S. National Museum, the materials belonging to the fore leg, restored by Marsh on the plate cited, are not in that museum and I therefore do not know just what parts were in Marsh's possession. From his language we have the right to suppose that he had at least the scapula, the coracoid, the humerus and some claws.[3] These parts, then, ought to be available in making comparisons with corresponding parts of related dinosaurs. Further differences between *Allosaurus* and *Creosaurus* are said by Marsh[4] to be found in the elongated sacral vertebræ of the latter genus and the transverse processes, which are placed higher up on the centra than in *Allosaurus*.

It appears to the writer that some animadversions may justly be made on the methods of preparing restorations of fossil animals, both as shown in the scientific journals and as displayed in our museums. It seems incontestable that the public has a right to know on what materials all reconstructions, as well as

[1] *Proc. U. S. Nat. Museum*, XXXV., pp. 351–66.

[2] "Dinosaurs of North America," Pl. XII., fig. 2.

[3] *Amer. Jour. Sci.*, XXVII., 1884, p. 334, Pl. XII., fig. 1.

[4] *Amer. Jour. Sci.*, XVII., 1879, p. 91.

all conclusions, have been based. If the reconstruction of a skeleton or a part thereof is a graphic one those parts which are uncertain or missing ought to be indicated by the style of the drawing. As an example to be disapproved let us take Professor Marsh's restoration of *Camptosaurus dispar*. In his "Dinosaurs of North America," Plate LVI., the skeleton is represented as complete, except the front extremity of the hip bone and the tip of the lower jaw, the predentary. Nevertheless, according to Mr. C. W. Gilmore, who has recently studied all the materials,[5] it is found that the skull was missing (except perhaps the lower jaw), nearly all of the dorsal vertebræ, all of the tail, a part of the scapula, a part of the coracoid and all of the ribs. The skull shown in the restoration is evidently that of *C. medius*;[6] and this in its turn was, according to Gilmore, restored partly from probably another species, *C. amplus*. The restoration of the reptile would have been far more valuable had the doubtful and missing parts been so represented.

As regards the restoration of the skeletons of fossil animals for exhibition a few words may be said. Where the actual bones enter into the preparation their value may be impaired either through their being put into inaccessible positions or being partly covered with plaster. Sometimes a skeleton or a part may be mounted in a slab of plaster so as to show one side, naturally the best one. The investigator worthy the name will burn to see that hidden side. Hence, means should be sought for concealing as little as possible of the precious bones.

In mounts where original materials are used in connection with artificial substances the latter ought to be plainly distinguished from the former. It was a complaint of some of Marsh's assistants[7] that one would have to go over some mounts with a moist sponge in order to distinguish plaster from bone. The practise now in the museums may not be quite so bad, but Barbour's test has sometimes, at least, been made ineffective by the application of a coat of shellac. Too often the texture and the color of the bone is imitated very closely. Then the device of a thin red line between the bone and the plaster and that of a small red cross on whole restored bones are employed. These, however, are hardly visible at a distance and are not understood readily by the visitor; and they do not appear in photographs and reproductions of them. The writer believes that there ought to be a decided difference between the color of the bone and that of the plaster. It may be that the appearance of a great mammal or reptile thus mounted will be somewhat variegated, but equally variegated is probably also our knowledge; and beauty ought not to be secured at the expense of truth.

It frequently seems that the restoration of missing parts represents lost labor. In the United States National Museum is a large part of the skeleton of the extinct bird *Hesperornis* which was mounted by Mr. F. A. Lucas. For sufficient reasons the missing sternum was restored in plaster. The few cervical vertebræ preserved are shown in their place on a rod of metal. Nothing would have been gained by restoring the missing cervicals and the missing skull; especially since a drawing in the exhibition case shows the visitor the form of the whole bird. The example is to be commended.

The visiting public ought to be shown the reasons for each restoration that has been adopted; and this because of its educational value. If the hind leg of a great dinosaur is missing it may be restored from the other, but differently colored, and then labeled as missing in the specimen and reproduced from the one present. If both legs are wanting and are restored from the limbs of another individual or from those of a related species, this fact should be stated and the attention drawn to those real limbs, in case they are in the museum. The interest of the visitor will thus be excited, he will make the problem of the expert his own problem, and will pass judgment on the work done.

The plain indication of the restored parts of

[5] *Proc. U. S. Nat. Mus.*, XXXVI., 1909, p. 270.

[6] Marsh, *op. cit.*, Pl. LVIII.

[7] *Amer. Naturalist*, XXIV., p. 388.

fossil animals is likewise a matter of common honesty. Emperors, grand dukes and millionaires may found museums, and they secure recognition for their munificence; but right at hand are the masses of the people who, in the end, foot the bills, and they have also their rights. The declaration that all men are born free and equal was not a more important one and one perhaps not so wholly true as is a principle said to have been uttered by one of our senators during the debate on the pure food law: The buyer has a right to know what he is getting for his money. The principle applies in all walks of life, however much it may fret those who would secure wealth, position and honors disproportionate to their deserts. Applying it to museum administration, we may say that the visitor has a right to know whether he is gazing at real bone or at plaster, and the reasons therefor. Moreover, it is futile and mischievous to attempt to hide the nature of the restoring materials. It is sooner or later detected and suspicion is thrown on the whole exhibit.

It is the practise sometimes to build up a fossil skeleton out of the bones of various individuals. This can not be condemned in all cases, but usually it is dangerous. It may be permitted to make a skeleton of the extinct auk from as many individuals as there are bones. In the case of less well-known animals, represented probably by fewer bones there is likely to result a mixture of species and even of genera. And no hybrids are so fertile as these, inasmuch as they reproduce themselves throughout the world by means of the printing press. And these hybrids are monsters besides, having legs belonging perhaps to two or three distinct animals, the head to another and so on. Of these can we not say with Horace, who was describing[8] an object made up of members gathered here and there,

> Spectatum admissi risum teneatis, amici?

And we may inquire if it advances science to send out over the world figures of an animal whose body belongs probably to one family and its head to another?

Rather than mingle the bones of several individuals belonging possibly to various species, it would be better to restore in plaster the various parts, except those of the principal individual, possibly of this also. Labels on the parts of the restored skeleton ought to direct the viewer to the bones, shown near by, on which the restorations have been based. As intimated, if visitors in the museums are not interested in plaster restorations and models it is probably because they believe that these things are products of the unchastened scientific imagination. There appears to be no other good reason why a plaster Megatherium should not be relatively as interesting as a plaster Venus of Milo. In these wholly artificial restorations the unknown parts should be as conscientiously indicated to the eye as in other cases.

And these plaster casts of the great animals that sojourned on the earth in bygone ages present another advantage that seems to be of the highest importance for the advancement of science. For now and anon some one among us, a paleontologist inchoate as yet but confident, the beneficiary of a favorable environment, bestriding his light-legged, straight-legged gypsiferous steed, perhaps *Brontodiplodococamarosaurus*, may gallop safely and merrily up the rugged slopes of the Mount of Fame.

Oliver P. Hay

[8] "Epis. ad Pisones," I., 5.

SOCIETIES AND ACADEMIES

THE ACADEMY OF SCIENCE OF ST. LOUIS

The Academy met at the Academy Building, 3817 Olive Street, Monday evening, April 19, 1909.

Dr. Robert J. Terry, of the Washington University Medical School, read a paper on "An Observation on the Development of the Vomer." The observations made on the development of the vomer in *Caluromys philauder* affects the question of the homology of the mammalian vomer. Is the single vomer of mammals comparable with the single parasphenoid or the paired vomers of lower forms? Except in man the vomer of mammals has been found to arise from a single center. Lately, however, the bone in question has been seen to be accompanied by a parasphenoid ossification. It seems also to be the case in *Caluromys* that the origin of the base is paired.

Dr. Joseph Grindon then spoke on "The Protection against Disease afforded by Certain Substances in the Blood." The facts are apparent as soon as one approaches the study of the phenomena of disease. First, that the natural tendency of the body is toward cure. Second, that certain species and certain individuals are immune toward certain diseases. This immunity may be relative or absolute, temporary or permanent, natural or acquired. These two facts may be considered together, having much in common. The older theories of immunity are either untenable or incomplete. The modern view distinguishes between immunity towards poisons, and immunity toward the invasion of bacteria, which secrete these poisons. In discussing the immunity toward poisons Dr. Grindon reviewed the production of antitoxins naturally and artificially, dwelling particularly on the side-chain theory of antitoxins. In speaking of immunity toward bacterial invasion, the speaker explained the formation and function of agglutinins and coagulins. Bacteria as a rule do not thrive in bodies of living animals, because of the presence of substances inimical to them. These bodies are called lysins, and consist of two components—the amboceptor and the complement. In concluding Dr. Grindon discussed phagocytosis and its application in practise.

THE Academy met at the Academy Building on Monday evening, May 3, 1909.

Professor F. E. Nipher, of Washington University, presented a paper on "Lessons to be Learned from Common Things."

Professor Wm. Trelease, director of the Missouri Botanical Garden, presented, with numerous lantern slides, an oral abstract of a paper on the "Mexican Fiber Agaves" known as zapupe, in which botanical names and descriptions were applied to five new species of *Agave*, all of economic importance.

The secretary of the entomological section reported that at the March meeting Mr. Hermann Schwarz spoke on "Collecting in Mexico," illustrated with many views and insects from that locality. At the April meeting Mr. Philip Rau exhibited a number of golden rod galls together with one species of diptera and species of hymenoptera which had emerged from them. Professor J. F. Abbott lectured on "Collecting in Japan," illustrated with lantern slides and coleoptera collected by him.

The following resolution was adopted:

Realizing that the whole country is taking stock of the natural resources which remain, and believing that the conservation in particular of the forest and water resources of the state of Missouri are of particular interest to the people of this state; realizing furthermore that available statistics show that there has been a decrease of 29 per cent. in the amount of lumber produced in the state during the last ten years; realizing furthermore the importance of conserving the forest and water resources of the state not only from the standpoint of the timber to be actually used in building and other purposes, but also with a view that the conservation of the forests within the boundaries of the state is desirable in order that the water supplies may be conserved, the farming lands preserved in their integrity and opportunities preserved for recreation grounds for the people; realizing also that some twenty-four states have already taken advanced steps, looking toward the conservation of their forest and water resources, be it

Resolved, that the Academy of Science of St. Louis endorses the report made by the forest and water commissions to the governor, and endorses the bills now pending before the legislature of Missouri, looking toward the appointment of permanent forest and water commissions, and that copies of this resolution be sent to the governor and presiding officers of the senate and house of representatives.

W. E. McCOURT,
Recording Secretary

THE AMERICAN CHEMICAL SOCIETY
NORTHEASTERN SECTION

THE ninety-third regular meeting of the section was held at the Twentieth Century Club, Boston, on May 28. Dr. Willis R. Whitney, president of the society, addressed the section upon "Colloids and the Brownian Movement." The speaker pointed out many striking similarities between the properties of ions and of colloidal particles. He also presented two different theories to account for the "Brownian Movement." Dr. James F. Norris, of Simmons College, addressed the section upon "The Base-forming Properties of Carbon." The speaker presented the results already obtained in his study of the relation between the structure of the alcohols and their reactivity with aqueous solutions of the halogen acids, and showed the bearing of this work upon our knowledge of the mechanism of salt formations in general.

K. L. MARK,
Secretary

SCIENCE

Friday, July 23, 1909

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of Science, Garrison-on-Hudson, N. Y.

THE DISTRIBUTION OF POISONS IN MUSHROOMS[1]

HISTORICAL INTRODUCTION

Edible and poisonous mushrooms have been of great popular interest from time immemorial, and the earliest histories attest the extensive use to which the harmless varieties were put, both by the peasant population of the world, forced by dire necessity to eat everything that grows, and by the wealthy classes, driven to the same end by the demands of the epicure's palate. Paulet[2] with whose "Traité des champignons" all mycologists must begin their studies, relates that mushrooms have from antiquity been sold, especially during Mid-Lent, in the public markets of Pekin, St. Petersburg, Florence and in other cities and towns in Tuscany. The ancient Babylonians and early Romans employed the edible species in great quantity, and the amanita which seems to me the most beautiful of all agarics, especially when the developing plants are seen in the mountains of North Carolina, the *Amanita cæsaria,* owes its name to a Latin ruler.

The most interesting of the early cases of mushroom or, as commonly described, toadstool poisoning and one of the first authentic cases on record, occurred in the family of the Greek poet Euripedes, who lost in one day, wife, daughter and two sons, who in the poet's absence partook of the deadly species. Among the great ones whose lives were sacrificed to the same ignorance may be mentioned the Pope Clement VII., the Emperor Jovian,

[1] Address delivered before a special meeting of the Boston Mycological Club, June 14, 1909.

[2] Paulet, "Traité des champignons," Paris, 1793.

the Emperor Charles VI., Berronill of Naples and the widow of the Tsar Alexis. The death of the Emperor Claudius is also assigned to this cause, but the reason and the manner of the accident are not certain. It is related that this worthy emperor wishing to rid himself of an uncongenial spouse, disposed of her by one of the many methods suitable for this beneficent purpose, and promptly took unto himself a younger, but alas, no better helpmate. His second choice failed to appreciate the kindly qualities of the emperor and compassed his death by substituting poisonous for edible mushrooms in his favorite meal. According to the pure toxicologists the same end was effected by the simple addition of mineral acid to the agarics served at the emperor's dinner, but as a loyal mycologist, I prefer to believe that the wily woman performed the more skilful trick of substitution.

Next to Paulet, mycologists owe more to Bulliard,[3] the famous French scientist, who was the first to systematically study and classify mushrooms and many of whose species are accepted to-day. We got from him our name "destroying angel" for the *Amanita verna* and modern investigation has but confirmed the conclusions of this fine old savant. In addition to Paulet and Bulliard the list of French authors who have contributed to our knowledge of the toxicology of the subject is long and includes such names as Cordier,[4] Bardy,[5] Gillot,[6] Guillaud,[7] Bourquelot[8] and many others, together with the various contributors to the monthly *Bulletin de la Société Mycologique de France,* now in existence since 1886. Important papers have been published also in Germany, in Italy, in England and in this country, and we now have a very considerable literature of both clinical and scientific interest.

Amanita Phalloides Bulliard

The "white or deadly amanita" is the cause of the greatest number of the cases of mushroom intoxication, if we include in this group the forms described as *Amanita verna, Amanita bulbosa, Amanita alba, Amanita virescens, Amanita mappa* and many other species known by various names in different localities. The group is indicated in Germany by the designation "Knollen-blätterschwamm." Its description and identification need not concern us at the present time, since there are many deaths on record with the same symptoms during life and identical post-mortem findings which indicate that one species, speaking now from the toxicological point of view, is responsible for the poisoning. The intoxication is characteristic in its course and in its result. The fungi are usually eaten by ignorant individuals, who gather what they find in the woods and consume them either raw or after thorough cooking. A small amount of the fresh material is sufficient to cause profound illness with fatal outcome, so potent is the poison contained in its meshes, and the raw plant seems usually more toxic than the cooked specimens. Two or three "deadly amanitas" suffice to bring on disastrous results, and Plowright[9] reports the death of a child of twelve from eating a third of the pileus of a small raw

[3] Bulliard, "Histoire des champignons de France," 1791–1812.

[4] Cordier, "Essai sur la toxicité de quelques champignons avant et après leur dessication," Lyon, 1899.

[5] Bardy, *Bull. Soc. Philomat. des Vosges,* 1883–84, 9.

[6] Gillot, "Etude medicale sur l'empoisonement par les champignons," Lyon, 1900.

[7] Guillaud, *Bull. Soc. Mycol. de France,* 1885, 1, p. 123.

[8] Bourquelot, article entitled "Champignons" in Richet's Dict. de phys., Paris, 1898, 3, p. 271.

[9] Plowright, *Lancet,* December, 1879, Vol. 2, p. 941.

plant. The extreme toxicity of this species illustrates the dangerous consequences which the admixture of two or three specimens to a dish of edible mushrooms entail.

Following the consumption of the fungi there is a period of six to fifteen hours during which no symptoms of poisoning are shown by the victims. This corresponds to the period of incubation of other intoxications or infections. The first sign of trouble is sudden pain of the greatest intensity localized in the abdomen, accompanied by vomiting, thirst and choleraic diarrhœa with mucous and bloody stools. The latter symptom is by no means constant. The pain continues in paroxysms often so severe as to cause the peculiar Hippocratic facies, "la face vulteuse" of the French, and though sometimes ameliorated in character, it usually recurs with greater severity. The patients rapidly lose strength and flesh, their complexion assuming a peculiar yellow tone. After three to four days in children and six to eight in adults the victims sink into a profound coma from which they can not be roused and death soon ends the fearful and useless tragedy. Convulsions rarely if ever occur and when present indicate, I am inclined to believe, a mixed intoxication, specimens of *Amanita muscaria* being eaten with the *phalloides*. The majority of individuals poisoned by the "deadly amanita" die, the mortality varying from 60 to 100 per cent. in various accidents, but recovery is not impossible when small amounts of the fungus are eaten, especially if the stomach be very promptly emptied, either naturally or artificially.

There have been many cases of phalloides intoxication reported in Italy, France, Germany and England, and fatalities from this cause in Canada and the United States are not uncommon. For several years I have collected newspaper accounts of toadstool poisoning and I should estimate that twelve to fifteen deaths occur annually in this country from this species alone. The most horrible of all epidemics ever reported occurred in France at the Orphanage of St. Louis near Pont de la Maye, Gironde, where eleven children died from one meal of *Amanita phalloides* gathered by the ignorant attendants.

TOXICOLOGY OF AMANITA PHALLOIDES

With the earlier investigations of Letellier,[10] published in 1826, probably the first work of a chemical nature upon fungi, of Letellier and Speneux,[11] of Bourdier,[12] of Oré,[13] French mycologists to whom we owe the names *Amanitin, Bulbosine* and *Phalloidin,* we need no longer concern ourselves, not because these men did not have in hand the active principle of *Amanita phalloides* at some time or other, but because the fungi employed by them embraced a number of species and included in all probability *Amanita muscaria.* Muscarine indeed seems to have been present in many of the poisonous extracts which they tested.

Our consideration of the properties of this fungus really must begin with the work of Kobert[14] who was the first to study *Amanita phalloides* in any painstaking manner. From carefully selected specimens of this species he obtained by alcohol precipitation a substance which

[10] Letellier, "Thèse de Paris," 1826.

[11] Letellier and Speneux, *Annales d'hyg. pub. et de med. leg.*, p. 71, 1867.

[12] Boudier, "Des champignons au point de vue de leurs caractères usuels, chimiques et toxicologiques," 1866.

[13] Oré, *Arch. de physiol. norm. et path.* (II.), XI., p. 274, 1877.

[14] Kobert, *St. Petersburger med. Wochenschr.*, XVI., pp. 463, 471, 1891.

had the remarkable property of dissolving red blood corpuscles, a substance known as an *hemolysin,* and which he named phallin. Very minute traces of this substance brought in contact with the red-blood cells of man or with those of many species of animals, produced within a short space of time, fifteen minutes to one or two hours, a complete solution of these corpuscles—a laking of the blood. So powerful was this hemolytic action that even in a dilution of 1–125,000 it was still operative upon the red cells of ox blood. This peculiar phenomenon was so striking that Kobert's attention was naturally riveted upon the substance producing it, since it corresponds so closely to *helvellic acid,* the first hemolytic substance described in fungi, and the active principle of the poisonous helvellas. The fact that phallin was precipitated by ethyl alcohol, resisted dialysis, etc., and that his extracts contained a little coagulable proteid, led Kobert to characterize it as a *toxalbumin,* a name now largely employed by serumologists to indicate a complex poison either itself proteid or so closely bound to proteid, that it must be regarded as proteid or albumin in its chemical nature. Despite certain peculiarities in the behavior of phallin which militated strongly against its acceptance as the active principle of *Amanita phalloides,* especially the destruction of the substance at 70° C., that is, much below the boiling point, Kobert concluded that it was the essential poison of this fungus and stated that the clinical symptoms and the post-mortem changes could be explained by its action. The publication of Kobert that *Amanita phalloides* owed its toxicity to a powerful blood-dissolving substance which, absorbed through the walls of the stomach circulated in the blood plasma, destroying the blood corpuscle as they met it, was a peculiarly enticing explanation for the mysterious phenomena induced by this most powerful of all poisonous fungi, and his explanation was universally accepted, especially in popular treatises on mycology. Kobert,[15] however, continued his study of specimens of *Amanita phalloides* and a few years later announced that the blood-laking principle phallin was occasionally absent from specimens of this species, but that all typical forms contained an alcohol-soluble poison, which killed animals in small doses but did not produce the typical lesions seen in man. This second substance Kobert believed to be a poisonous alkaloid, but gave no satisfactory reason for his characterization of this poison as such.

The second communication of Kobert's had little or no circulation and was never known, I believe, to the majority of mycologists. Personally I was quite ignorant of its existence for some time after I began investigations in this field. During the summer of 1903, now six years ago, I collected a considerable number of specimens of *Amanita phalloides* in Blowing Rock, N. C., only the plants corresponding closely to the classic descriptions and which could be regarded as typical being accepted. During the following winter a careful study of these fungi was instituted. The thoroughly dried material was extracted with distilled water, the extract passed through a Berkefeld filter, and its action studied upon all varieties of blood corpuscles, and upon animals. Subsequently during the summer of 1904 and 1905 I collected in the Blue Ridge Mountains of Maryland and a year later in Woods Holl, Mass. The following season

[15] "Sitzungsberichte der naturforschenden Gesellscheft zu Rostock," p. 26, 1899, Anhang to the *Archiv des Vereins der Freunde der Naturgeschichte in Mecklenberg,* III., 1899, II. Abtheilhung.

Dr. Abel, professor of pharmacology in the Johns Hopkins University, collected in New York state, and then again in New Hampshire. We have thus had a considerable amount of material for study, gathered from widely separated areas.

During the first winter's work[16] I was able to confirm Kobert's assertions as to the presence of a powerful hemolysin in *Amanita phalloides*. I found it acted upon blood corpuscles from nearly every animal tested, and that it corresponded somewhat in its action to hemolysins derived from bacterial filtrates. At the same time it was at once apparent that this fungus always contained another poison which differed from the hemolysin in being resistant to heat and digestion, the blood-laking substance phallin, being destroyed by heating to 70° C., and by the action of the digestive ferments. To this second substance I gave the name amanita-toxin[17] reserving for the blood-laking principle the name amanita-hemolysin, in order to clearly differentiate between these poisons, regardless of any question as to the active principle. The work was now taken up from the chemical standpoint and under Dr. Abel's direction a number of important problems have been solved. In the first place he and I[18] have shown that aqueous extracts of *Amanita phalloides* contain two poisons which may be separated by concentration to a small bulk and precipitation by ethyl alcohol. The precipitate contains the amanita-hemolysin, the filtrate the amanita-toxin. This hemolytic substance we have shown to be not a toxalbumin, as Kobert believes, but a very sensitive glucoside, that is, a substance which contains sugar in its molecule, and which when split up into its component parts will give the most important reactions for sugar, namely, the reduction of Fehling's solution and ammoniacal silver nitrate. Furthermore we[19] have developed a method for the isolation and purification of this substance, and have finally been able to show that it is an extremely complicated poison containing fixed amounts of carbon, nitrogen, hydrogen and sulphur. The importance of these observations lies not only in the practical application of the method we have developed to the examination of other fungi, but also in certain theoretical questions of immunity. This substance is the poison in *Amanita phalloides* to which a high grade of immunity can be established in animals and for which I have repeatedly obtained an anti-poison or an anti-hemolysin, the action of which is to completely neutralize its blood-laking properties.

Schlesinger and I[20] at the same time have shown that the amanita-toxin can be isolated and purified by certain well-defined methods, and in its pure state is one of the most powerful poisons of organic origin known, four tenths of one milligram killing a guinea-pig within twenty-four hours. At first thought to be a conjugate sulphate, I have recently found, in association with Mr. Prouty, that conjugate sulphate can not be split off from the amanita-toxin. The exact character of this poison is still under investigation. These two substances, the amanita-hemolysin and the amanita-toxin, are the only poisons we have thus far encountered in *Amanita phal-*

[16] Ford, *The Journal of Infectious Diseases*, Vol. III., No. 2, April, 1906, pp. 191–224.

[17] Ford, *The Journal of Experimental Medicine*, Vol. VIII., No. 3, May 26, 1906, pp. 437–450.

[18] Abel and Ford, *The Jour. of Biol. Chem.*, Vol. II., No. 4, January, 1907, p. 273.

[19] Abel and Ford, *Arch. f. exp. Path. et Pharm.*, Supplement-Band, Schmiedeberg Festschrift, 1908.

[20] Schlesinger and Ford, *Jour. of Biol. Chem.*, Vol. III., No. 4, September, 1907, p. 279.

loides. The hemolysin we believe to play no rôle in human intoxications, the toxin being the active principle—since it can be boiled and resists the action of the gastric juice. I have furthermore pointed out[21] that the lesions seen in fatal cases of poisoning in man can be reproduced in animals by the amanita-toxin alone, but I am by no means certain that the amanita-hemolysin can be entirely eliminated in human intoxications. This substance is at times present in *Amanita phalloides* in the greatest abundance, and is more resistant to heat than is usually believed. Should the fungi be eaten raw or only partially cooked, this poison might escape the action of the digestive ferments, especially if these be deficient in quantity or quality, and assist the amanita-toxin in its deadly work. Against this possibility we have the fact that *Amanita rubescens*, considered by the majority of mycologists to be an edible mushroom, contains a hemolysin equally powerful with that of *Amanita phalloides*. We can only say that the heat-resistant amanita-toxin is the active principle in the sense that by itself it is capable of causing a fatal intoxication even if the hemolysin is inactive. Nevertheless the fact that the amanita-hemolysin may exert an adjuvant action in cases of poisoning raises at once the question whether fungi containing hemolytic substances should be regarded as entirely safe.

Kobert[22] in the chapter on fungi in his recent text-book ascribes to *Amanita phalloides* first, a blood-laking substance, phallin, which he states to be a toxalbumin despite the observations of Dr. Abel and myself which prove that the hemolysin in this fungus is a glucoside, secondly, an alcohol-soluble poison, not producing fatty degeneration, which he believes to be an alkaloid, and finally a third hypothetical poison, a toxalbumin like thujon and pulegon, certain complex substances found in plants (pennyroyal). In the second poison Kobert is probably dealing with the amanita-toxin, which is not an alkaloid and which I think does produce fatty degeneration, and his third poison is purely supposititious. He himself presents no evidence of its existence, and while we can not deny that *Amanita phalloides* may contain at times other poisons not noted by us, we are inclined to the opinion that the amanita-hemolysin and the amanita-toxin are the most important, if not the only ones.

Specimens of small amanitas collected in the Blue Ridge Mountains of Maryland and identified as *Amanita verna* Bulliard were presented in special lots. When examined their properties were quite the same as those of *Amanita phalloides*. The strength of both hemolysin and toxin, however, was considerably greater when the weight of the dried specimens was considered.

Amanita muscaria Linnæus

The species known as the "fly agaric" (Fliegenpilz or Fliegenschwamm of the Germans) has been recognized from early times as deadly poisonous, the first accident on record being possibly that of Madame the Princess of Conti in Fontainebleau in 1751. This, however, did not terminate fatally. *Amanita muscaria* is a beautiful species when fully developed and to a certain extent it resembles *Amanita cæsaria* or *Amanita aurantiaca*, French writers distinguishing between the two species by referring to the edible form as the "oronge vraie" and to the poison-

[21] Ford, *Jour. of Infect. Dis.*, Vol. 5, No. 2, March 30, 1908, pp. 116–132.

[22] Kobert, "Lehrbuch der Intoxikationen," Zweite Aufl., II[2], p. 625, 1906.

ous species as the "oronge fausse." It can easily be recognized by even beginners in mycology and is now commonly avoided. Poisoning results from ignorance, the species in question being selected for its beautiful color and form, or from mistakes in identification, *Amanita muscaria* being taken for the *cæsaria* or the *aurantiaca*. In addition there is another factor which is possibly the cause of the majority of accidents in this country, especially those occurring with individuals possessing some knowledge of mycology. In Italy and in France and in certain parts of Austro-Hungary *Amanita muscaria* is apparently somewhat reddish in color, while *Amanita cæsaria* is of a lighter yellow tone. The most commonly found *Amanita muscaria* in this country is of a light to a deep yellow in color, not showing the reddish tinge, while *Amanita cæsaria* is either of the reddish-yellow hue or even of a beautiful reddish-brown.

Persons familiar with the two species in the old world might very easily draw wrong conclusions in identifying those found in the new. I base this opinion largely upon a comparison of the colored plates of the text-books of mycology published in different countries and upon the specimens of "Cæsar's agaric" and the "fly agaric" I have myself found in the Blue Ridge Mountains. This assumption is furthermore borne out somewhat by the literature of "muscaria poisoning" for in many instances the victims were Italians or Poles who stated before death that they ate the fungi under the impression that they were eating the "royal agaric." This was apparently the cause of the poisoning of the Count de Vecchi and his physician in Washington which Prentiss[23] has reported with great care. The Count, an attaché of the Italian legation, a cultivated gentleman of nearly sixty years of age, considered something of an expert upon mycology, purchased, near one of the markets in Washington, a quantity of fungi recognized by him as an edible mushroom. The plants were collected in Virginia about seven miles from the city of Washington. The following Sunday morning the count and his physician, a warm personal friend, breakfasted together upon these mushrooms, commenting upon their agreeable and even delicious flavor. Breakfast was concluded at half after eight and within fifteen minutes the count felt symptoms of serious illness. So rapid was the onset that by nine o'clock he was found prostrate on his bed, oppressed by the sense of impending doom. He rapidly developed blindness, trismus, difficulty in swallowing and shortly lost consciousness. Terrific convulsions then supervened, so violent in character as to break the bed upon which he was placed. Despite rigorous treatment and the administration of morphine and atropine, the count never recovered consciousness and died on the day following the accident. The count's physician on returning to his office was also attacked, dizziness and ocular symptoms warning him of the nature of the trouble. Energetic treatment with apomorphine and atropine was at once instituted by his colleagues and for a period of five hours he lay in a state of coma with occasional periods of lucidity. The grave symptoms were ameliorated and recovery set in somewhere near seven o'clock in the evening. His convalescence was uneventful, his restoration to health complete, and he is, I believe, still living. In this instance the count probably identified the fungi as *cæsaria* or *aurantiaca*. From the symp-

[23] Prentiss, *Phil. Med. Jour.*, 1898, 2, pp. 607–611.

toms and termination the species eaten must have been *muscaria.*

These two cases are not typical of this intoxication. In the majority of instances *Amanita muscaria* has a bitter, unpleasant taste and on this account is not eaten in great quantity. Consequently the intoxication is not so profound and the fatalities are fewer in number. Moreover the action of the poison is mainly directed against the nerve centers and if this action be neutralized by atropine, or if the nerve centers are not completely overwhelmed, its effect gradually wears off, without any permanent lesion. Not so with *Amanita phalloides,* where the amanita-toxin is the cause of such profound degeneration in the internal organs, heart, kidney and muscles, as to make recovery a far more arduous task for nature to accomplish.

The active principle of *Amanita muscaria* is muscarine, an alcohol-soluble crystalline substance first isolated from this species by Schmiedeberg and Koppe[24] and usually classed with the ammonia bases. It will reproduce in animals the intoxicacation seen in man and is without doubt the chief poison present. Muscarine has also been prepared synthetically, by the oxidation of choline, but the artificial body does not produce quite the same symptoms and it is easily decomposed. Moreover muscarine is apparently not the only poison present in this plant. It has been shown on clinical grounds that even when this drug is completely neutralized by its perfect physiological antidote, atropine, the patients who have eaten *Amanita muscaria* sometimes die, and Harmsen, from a series of carefully conducted experiments, concludes that another poison exists in *Amanita muscaria,* the so-called "Pilztoxin." This fungus is probably most widely known from the habits of the peasants of the Caucasus who prepare from it an intoxicating beverage which produces wildly riotous drunkenness. Death from a muscarine orgy is not uncommon in this part of Russia and a member of the ruling family is said to have lost his life in that way. *Amanita muscaria* collected in the Caucasus is said to be deficient in muscarine, but the universal testimony of medical writers would indicate that this is not the case, but that rather a kind of tolerance develops among the habitual users of the *muscaria* decoctions. We do not know, however, whether muscarine is present in *Amanita muscaria* in the same quantity at different periods of the year nor have we any knowledge of the effect of soil and climate upon its distribution. The only antidote for this poisoning is atropine, which, however, is so potent in this respect as to almost completely neutralize the muscarine and hence the outlook in this intoxication is far more hopeful than in any other.

RARELY POISONOUS SPECIES

Amanita pantherina De Candolle, a species closely resembling *Amanita muscaria,* is occasionally the cause of mushroom poisoning, but the intoxication is not profound and but rarely does death ensue. The symptoms come on within a few hours after eating, and consist of great excitement, delirium, convulsions and a peculiar drunkenness not unlike that described among the Koraks. The Japanese variety is said by Inoko[25] to represent *Amanita muscaria* for Japan, being used there as a fly poison in place of the latter species, which is rare and devoid of any poisonous quality. Inoko has isolated muscarine from this Japanese *Amanita pantherina*

[24] Schmiedeberg and Koppe, "Das Muskarin," Leipzig, 1869.

[25] Inoko, *Mittheil. a. d. Med. Fac. de K. Jap. Univ. Tok.,* 1890, 1, No. 4, pp. 313–331.

and has reported an extensive series of intoxications. The victims showed in addition to vomiting, diarrhœa, and a dilatation of the pupils, peculiar nervous manifestations. The feeling of "bien-être" expressed by singing and laughing, the sensation as of insects crawling over the skin, visions of beautifully colored reptiles and snakes, red, yellow and brown, all contribute to give us a picture of a peculiar mental state, which differs from that described among the Russians, not so much in the kind of drug causing the symptoms as in the different psychology of the Oriental as compared with the Tartar. In all cases the intoxication with *Amanita pantherina* is mild and recovery the rule.

The poisonous fungus *Helvella* or *Gyromytra esculenta* Fries occurs so rarely in this country and is so seldom the reputed cause of illness at the present time, that we need not pay any particular attention to it beyond referring to its active principle, Helvellic acid, isolated by Boehm and Külz.[26] This is a hemolytic or blood-destroying substance, soluble in hot water, which when given to dogs by mouth will reproduce the lesions found in man with all the signs of a hemolytic intoxication. Other species of mushrooms like *Russula emetica* cause profound gastro-intestinal disturbances such as a sharp attack of vomiting and diarrhœa, recovery following emptying of the stomach and bowel of the irritating plant. Certain of the rank-smelling phalloideæ which exhale an offensive odor and are of course never eaten by man, are eagerly devoured by swine with uniformly fatal consequences. Gillot (*l. c.*) states that one or two species of *Volvaria* have caused death when eaten, but nothing is known of the nature of the intoxication or of the active principle. Finally the poisonous *Boletus luridus* or *Boletus satanus* may occasionally be the cause of transient disturbances in man, but the plants have such a rank, unpleasant taste as to forbid their consumption in any quantity. These species have been said to owe their toxicity to muscarine. The question as to whether the ordinary edible mushrooms, as distinguished from the poisonous toadstools, may not in certain localities or at certain periods of the year be the cause of fatal intoxication, may be answered, I am sure, in the negative. Old or badly decomposed specimens may cause transient illness, and I remember well an attack of cholera-morbus which I experienced in Paris from eating dried specimens of the meadow mushroom, purchased in the open market. There are, however, no authentic cases of *poisoning* from the black or brown spored agarics and when investigated in the laboratory, these species are found free from toxins. The three or four forms already mentioned are the only ones thus far *proved* to be poisonous and the only ones with which laboratory investigation has confirmed clinical observation.

In addition to *Amanita phalloides* and *Amanita verna,* I have also analyzed *Amanita rubescens* Persoon[27] collected at Woods Holl, Mass., and a species from the same place which I identified as *Amanita solitaria* Bulliard. It corresponded closely in its general appearance to the plates and descriptions given for this species. In *Amanita rubescens* I found a powerful blood-destroying substance like the amanita-hemolysin which could be freed from proteid and which gave the reactions for glucosides. *Amanita solitaria* had a peculiar action upon blood corpuscles, causing their agglomeration in densely adherent

[26] Boehm and Külz, *Arch. f. exp. Path. u. Pharm.*, 1885, 19, p. 403.

[27] Ford, *Jour. of Infect. Dis.*, Vol. 4, No. 3, June, 1907, pp. 434–439.

clumps, the phenomenon spoken of in bacteriology as *agglutination,* but in addition the corpuscles were slowly dissolved. Neither species contained any amanita-toxin. Both *Amanita solitaria* and *Amanita rubescens* are regarded by mycologists as edible. If they can be eaten by man, these substances acting "in vitro" upon the blood corpuscles must either be destroyed in cooking or be digested in the stomach and intestines, or the species must vary in their properties.

SPECIES COLLECTED IN 1908

For a long time I had been anxious to examine some of the rarer species of fungi which closely resemble the deadly poisonous forms, and also some of the species which are said to be *dangerous,* occasional intoxications from their use having been reported in the older literature. The opportunity of doing so was afforded me through the kindness of Mr. George E. Morris, of Waltham, Mass., who sent me last fall a number of fungi which he had himself procured, together with specimens collected by Mr. Simon Davis, of Brookline, Mass., and some from the general collection of the Boston Mycological Club. These mushrooms were accurately identified in the fresh state, carefully dried in a drying oven, wrapped in separate packages, labeled with the name of the finder and the place and date of finding. The specimens were analyzed "seriatim" in the laboratory. The results of this work will be reported in detail later, but tonight the principal conclusions drawn from the study of these forms may be briefly commented upon. It is essential, when looking into the properties of the rarer fungi, especially the amanitas, that the various species studied should have been identified by expert botanists, and I feel very fortunate in this respect in having material vouched for by such well-known mycologists. One species of *Amanita phalloides* obtained by Mr. Davis at Stow was found to contain the poisons typical of this species. Their strength was somewhat less than usual, but the action upon blood corpuscles and upon animals was identical with that usually found. Two lots of *Amanita virosa* Fries were examined: one obtained by Mr. Morris in Cohassett, and another by Mr. Davis in Stow. In both instances hæmolysin and toxin were present in maximum quantities. An extract of fungus in which the dried material was utilized in the proportion of six grams to fifty cubic centimeters of water gave a hemolysin active in a dilution of 1–200, and subcutaneous injection of the extract killed guinea pigs within twenty-four hours with the symptoms and lesions of an acute intoxication. *Amanita virosa* thus is identical with *Amanita phalloides.* Specimens of *Amanita spreta* Peck collected by Mr. Morris in Stow and by Mr. Davis in the same locality were identical in their action. In the proporton of six grams of dried fungi to sixty cubic centimeters of water a hemolysin was present in both instances, in a strength of 1–20 and the inoculation of animals with the heated extract produced a typical chronic intoxication. While the poisons are by no means as powerful as those in *Amanita virosa* they are of the same character. *Amanita spreta* is described by Atkinson[28] with the words "said to be poisonous." Although no cases of intoxication have thus far been reported in the literature, the species must be classed with the "deadly poisonous." *Amanita phalloides* Bulliard, *Amanita verna* Bulliard, *Amanita virosa* Fries and *Amanita spreta* Peck, may thus be grouped

[28] Atkinson, "Mushrooms," 1903, p. 69.

together in their toxicological properties. *Amanita rubescens* Persoon from the collection of Mr. Morris at Stow and a yellow form of *Amanita rubescens* from the Boston Mycological Club were examined by the routine method. The *rubescens* from Mr. Morris's collection was devoid of hemolysin and toxin alike, while the yellow form contained an active hemolysin but no toxin. A more careful study of the species *rubescens* must be made before a positive conclusion can be drawn concerning its properties. Four of the rarer species of *Amanita* may be described together because of their similarity, namely, *Amanita strobiliformis* Vittadini found by Mr. Morris in Ellis, *Amanita chlorinosma* Peck from the collection of the Boston Mycological Club, *Amanita radicata* Peck found by Mr. Morris in Ellis and *Amanita porphyria* Albertini and Sweinitz from the same place.

These four species were alike devoid of hemolysins, but contained in small quantities a poison which is practically identical with the amanita-toxin. It is resistant to heat, soluble in alcohol and kills animals slowly, but with many of the lesions found in phalloides poisoning. These fungi should all be considered "deadly poisonous," and future experience may even show that hemolysins are also present in other forms of the same species, in which case they would be practically identical with the "deadly amanita."

Two specimens of *Amanita muscaria* Linnæus were given me, one found by Mr. Morris and the other by Mr. Davis in Stow. The properties of these forms were identical with those of *Amanita muscaria* obtained for me six years ago by Dr. W. H. Lewis, in Woods Holl, Mass. The species thus seems very constant in its characteristics. All three samples contained muscarine, the aqueous and alcoholic extracts killing animals in two hours with the usual symptoms. The alcoholic extract contained in addition a peculiar hemolysin, the properties of which are still under investigation, while in the aqueous extract evaporated to a small bulk and precipitated by ethyl alcohol I found an *agglutinin* such as has been previously described for *Amanita solitaria.* The development of our methods of analyzing fungi enabled me to *isolate* this substance, which turned out to be a glucoside, but not one containing pentose. Although agglutinins are not uncommon in various plants, this is, I believe, the first time that one has been isolated by chemical methods, and the first time that a glucoside has been found to exert this action upon blood corpuscles.

Amanita frostiana Peck, three specimens of which were found by Mr. Morris in Stow and one at Cohasset were individually examined. They contained in all instances an hemolysin of low grade intensity, but the heated extracts were without action upon animals. Neither amanita-toxin nor muscarine could be demonstrated. The absence of resistant poisons from this species is particularly interesting since *Amanita frostiana* was first described by Peck as a minor variety of *Amanita muscaria,* and is put down by Atkinson[29] as "poisonous." The specimens sent me were certainly devoid of muscarine, a fact which suggests that the species may not be so closely related to *Amanita muscaria* as is indicated by its botanical characters. Further observations must be made with other forms of *Amanita frostiana* to determine whether it is uniformly free from the poison described by Schmiedeberg. Finally three specimens of *Amanita russuloides* Peck, one found at Natick by Mr. Morris, another at Stow by Mr. Morris, and a third at

[29] Atkinson, "Mushrooms," 1903, p. 54.

Stow by Mr. Davis proved to be quite free from poisons of any description. In one instance a slight hemolytic action was observed, but this was attributed to the acid reaction of the fungus. In all cases the heated extracts were without effect upon animals. This species is considered edible by most mycologists.

GENERAL CONCLUSIONS

The examination of these various species of fungi, representing now nearly twenty distinct forms, demonstrates one or two facts which should be particularly emphasized. In the first place, our methods of chemical analysis of mushrooms, and especially the methods of isolating their poisons are now so developed that a little material, two or three small specimens in fact, and even one good sized plant, may be studied and an opinion be given as to the properties of the species. In the second place, a more extended investigation should be carried out in regard to the properties of all the mushrooms believed on clinical grounds to be poisonous, but of which no laboratory study has thus far been made. Finally such a piece of work, to be of lasting value to science, can only be accomplished through the cooperation of trained mycologists who can identify with certainty the species of mushrooms selected for study.

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June 20, 1909

NOTES ON ELECTRICAL ENGINEERING AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

THE cause of electrical engineering research and the advanced instruction of graduate students in electrical engineering has been advanced by the appointment of Dr. Harold Pender to the professorship of theoretical and applied electricity which is connected with the department of electrical engineering at the Massachusetts Institute of Technology. Dr. Pender is a graduate of Johns Hopkins University and took the degree of Ph.D. at that university in 1901 under the direction of Professor Rowland. He thereafter taught for a year and a half, during which period he completed the classical experiments of Professor Rowland which demonstrated the magnetic effect of a moving charge of electricity. M. Poincaré having suggested the desirability of these experiments being performed in Paris, the Carnegie Institution of Washington arranged with Dr. Pender to go to France for the purpose. Upon returning from France Dr. Pender went into the employ of the Westinghouse Electric Company and he has since been in regular engineering employ. His teaching at the Institute of Technology will consist of a course for third-year undergraduate students and courses for graduate students in the more advanced theories of electric current flow and the electric transmission of power, in addition to the direction of experimental research by advanced students.

The advanced lectures on the organization and administration of public service companies, on the design of power stations and systems, and on electrical measurements heretofore carried on by Professor Jackson, Professor Shaad and Professor Laws will be continued by the same professors.

As indicating the trend of electrical engineering study at the present time, it is notable that forty per cent. of the students just graduated from the electrical engineering course at the Massachusetts Institute of Technology already bore degrees of bachelor of arts or science, conferred, as a rule, in classical or literary courses. These men are going into a wide variety of activities, from the manufacture of electric instruments and of incandescent lamps to electric transmission of power and heavy electric traction.

Mr. H. S. Osborne and Mr. W. S. Rodman, who are candidates for the degree of doctor of engineering in the electrical engineering department, have recently been appointed fellows by the faculty of the institute. Mr. R. L. Jones has been appointed graduate scholar in electrical engineering.

EDUCATIONAL SECTION OF THE BRITISH ASSOCIATION

THE section will assemble on Thursday, August 26, in the Senate House of the University of Manitoba, Winnipeg, under the presidency of the Rev. H. B. Gray, D.D., Warden of Bradfield. After the president's address a discussion on moral instruction in schools will be opened by Professor L. P. Jacks, editor of the *Hibbert Journal*. He will be followed by Mr. Hugh Richardson, of the Friends' School, Bootham, York, and it is hoped that American and Canadian educationists will also take part.

On Friday, the twenty-seventh, there will be a discussion on practical work in schools, which will be opened on behalf of the subcommittee of the association which is now considering the question, by Mr. W. M. Heller, chief inspector of science work under the commissioners for elementary education in Ireland. Dr. C. W. Kimmins, vice-president of the section and chief inspector of schools under the London County Council, will contribute some account of the London Trades Schools. Miss Lilian J. Clarke, of the James Allen School, Dulwich, examiner in the University of London, will speak on practical work in girls' secondary schools, and Mr. W. Hewitt, director of technical education in Liverpool, on practical work in evening and continuation schools.

On Monday, the thirtieth, there will be a joint meeting with the Geographical Section of the association for the discussion of geography teaching. Professor R. E. Dodge, of Columbia, and Professor G. G. Chisholm, of Edinburgh, are expected to open the discussion. There will also be a discussion on the relations of universities and secondary schools, with special reference to the accrediting and examining systems.

On Tuesday the president of the section will open a discussion on education as a preparation for agricultural life, with special reference to Canadian conditions. If time permits it is also intended to discuss the subject of consolidation schools.

The committee of the section are in correspondence with educationists in Canada and America, and they hope to arrange that each subject shall be opened by representatives of American, Canadian and British education. American educationists who may be attending the meeting of the association will be welcomed at the sectional meeting.

The local secretary for the meeting is Mr. D. M. Duncan, of the University of Manitoba, Winnipeg, and the recorder is Mr. J. L. Holland, secretary for education in Northamptonshire, of Northampton, England. Offers of contributions on any of the subjects set for discussion may be made to either of these gentlemen, and will be considered by the committee of the section.

SCIENTIFIC NOTES AND NEWS

A PORTRAIT of Dr. J. W. Mallet, professor of chemistry in the University of Virginia, has been presented to the university by his former students. It is the work of Mr. Duncan Smith, a son of Dr. Mallet's colleague and life-long friend, Professor Francis H. Smith.

SIR JOSEPH DALTON HOOKER celebrated his ninety-second birthday on June 30. His scientific career began seventy years ago, when he went out as surgeon and naturalist with Sir James Ross's Antarctic expedition.

DR. C. GORDON HEWITT, lecturer in economic zoology in the University of Manchester, has been appointed entomologist to the Dominion of Canada in succession to the late Dr. James Fletcher.

DR. E. F. NICHOLS, professor of physics at Columbia University, assumed the presidency of Dartmouth College on July 15. The formal installation will take place in October.

PROFESSOR KARL RUNGE, of the department of mathematics in the University of Göttingen, has been appointed Kaiser Wilhelm professor at Columbia University for next year.

THE Fritz Schaudinn medal for work in microbiology has been awarded to Dr. Stanislaus von Lanow, Schaudinn's successor in the Hamburg Institute for Marine and Tropical Diseases.

DR. W. STIRLING, professor of physiology in the University of Manchester, has been elected a foreign corresponding member of the Turin Academy of Medicine.

WE learn from *Nature* that the council of the Royal Society has awarded the Mackinnon studentships for the year 1909 as follows: one in physics to Mr. R. D. Kleeman, of Emmanuel College, Cambridge, for the continuation of his researches on radio-activity, which he proposes to conduct at the universities of Cambridge, Leeds and Manchester; the other, in biology, has been renewed for a second year to Mr. D. Thoday, of Trinity College, Cambridge, for research into the physiological conditions of starvation in plants and its relation to the responsiveness of protoplasm to stimulation, especially to stimuli affecting respiration.

PROFESSOR J. H. JEANS, whose resignation from the chair of mathematics at Princeton University has been announced, will return to his home in Cambridge, England.

MR. H. C. SIMS, of the Field Museum of Natural History, has started for the Ilongo country in the Philippines to continue the work which was interrupted by the death of Dr. William Jones.

PROFESSOR CHARLES E. BESSEY, of the University of Nebraska, is giving a course of lectures at the Marine Station at Orcas Island at Olga on Puget Sound. During August he expects to join Professor E. A. Bessey in a botanizing expedition in the Rocky Mountains.

PROFESSOR WILLIAM H. HOBBS, of the University of Michigan, expects to join Professor Tarr and Professor Martin in the Yakutat Bay region of Alaska and afterwards to attend the Winnipeg meeting of the British Association.

DR. ROLAND B. DIXON, assistant professor of anthropology in Harvard University, is spending the summer in New Zealand and Australia.

DR. R. M. STRONG, of the department of zoology of the University of Chicago, will sail for Europe on August 7. He plans to return about the end of March, 1910.

THE magnetic survey yacht *Carnegie* will leave New York early in August for a cruise of six to seven months embracing Hudson Bay, the North Atlantic and return via Madeira and Bermuda. Mr. W. G. Peters will be in command, Captain C. E. Littlefield, the sailing master, Dr. C. C. Craft, surgeon and observer, Messrs. J. T. Ault, E. Kidson and R. R. Tafel, magnetic observers, and F. D. Smith, observer-engineer. Besides the scientific party and the sailing master, the *Carnegie* carries a crew consisting of two watch officers, eight seamen and two cooks. The director, Dr. L. A. Bauer, will accompany the vessel as far as St. Johns, Newfoundland, and possibly to some point in Labrador. Mr. D. F. Smith, graduate of the University of Maine, 1905, and connected for the past three years with the Technologic Branch of the U. S. Geological Survey as expert on gas engines and gas producers, has been appointed observer-engineer on the *Carnegie*. He will have special charge of the machinery installation. The *Carnegie* is equipped with a four-cylinder Craig internal combustion engine of 150 horse power, sufficient to drive the vessel six knots in calm weather. The gas producer was furnished by the Marine Producer Gas Co., of New York. Both the engine and the producer are constructed practically of non-magnetic materials.

THE Joseph Eichberg fund for the establishment of a memorial chair of physiology in the medical department of the University of Cincinnati, now amounts to $45,000.

THE *Journal of the American Medical Association* states that a memorial to Kussmaul was unveiled at Freiburg, May 15, with much ceremony, and the German journals of the first week in June contain views of the bust that surmounts the shaft and the allegorical figure on the base representing the art of healing. A tablet to Auenbrugger, the "father of percussion," has also recently been installed at Vienna, and a large statue of Pettenkofer unveiled at Munich. A memorial to Mikulicz was also unveiled at Breslau on May 27; it stands in front of the clinic he made famous, and the address was delivered by his successor,

H. Küttner. In Madrid, also, a tablet was installed in the Colegio de Medicos the same week, to the memory of F. G. Roel, noted in connection with the first description of pellagra. His will is said to be such an interesting document that the Academy of Medicine is to republish it shortly.

JOHN MORSE ORDWAY, until three years ago professor of metallurgy at Tulane University, has died, at the age of eighty-six years.

MR. LEFFERTS BUCK, an engineer known especially for his work on bridges, died in his home in Hastings, N. Y., on July 17, at the age of seventy-two years.

THE deaths are also announced of Dr. Frank Kelton Bailey, instructor in physics in the Ohio State University, and of Dr. Theodore R. Wolf, professor of chemistry in Delaware College.

DR. T. W. BRIDGE, F.R.S., professor of zoology at the University of Birmingham, known for his work on ganoid fishes and teleosts, died on June 30, at the age of sixty-one years.

DR. VITTORIO RAFFAELE MATTEUCCI, director of the Royal Observatory on Mt. Vesuvius, well known for his studies in seismology, died on July 16, at the age of forty-nine years.

THE heirs of the late Herr Heinrich Lanz, head of the Mannheim engineering firm, have given a million Marks for the establishment of an academy of sciences at Heidelberg.

THE local secretaries for the forthcoming British Association meeting at Winnipeg desire to point out that the proposed excursion up the coast of British Columbia to Alaska, now being organized in connection with the Natural History Society of Canada, is unofficial and is not part of the local committee's arrangements. Those desiring, therefore, to make this journey before the meeting should communicate with Moses B. Cotsworth, Victoria, B. C.

THE annual meeting of the British Medical Association will begin in Belfast next week. On July 27, Sir William Whitla will be inducted into the office of president by Mr. Sinclair White and will deliver his address.

A NEW society has been formed in Great Britain, known as the Institution of Mining Electrical Engineers. Local sections have been established at Newcastle and for the Glasgow district of Scotland. The first general meeting of the society will be held in September.

M. G. DARBOUX has been reelected president of the Société des Amis des Sciences, MM. Aucoc and Picard vice-presidents and Professor Joubin general secretary. *Nature* states that the society was founded in 1857 by Baron Thenard with the view of assisting unfortunate inventors, men of science and professors and their families. Among the names of past-presidents of the society occur those of Thenard, J. B. Dumas, Pasteur and others. Since its foundation the society has distributed in pensions and grants more than two and a half million francs. This year eighty pensions have been granted to aged scientific men or their widows. The society has assisted the education of some seventy children and has made grants to thirty-five widows.

THE *Medical Record* states that plans have been completed for the new psychiatric ward of the Johns Hopkins Hospital which is to be built by Mr. Henry Phipps, of New York. The building will be of dark brick and stone to resemble the other buildings of the hospital, but the interior will be quite different from the usual hospital ward. The white coloring common to hospitals will be omitted, and the rooms will be made as homelike as possible. The idea of non-restraint will be carried out as much as possible. The court will be made into a garden, and the windows will be guarded by flower boxes and trellises instead of bars. Extensive arrangements for recreation and exercise will be supplied.

A COOPERATIVE soil survey of Wisconsin is soon to be begun under the direction of the state Geological and Natural History Survey and the College of Agriculture of the University of Wisconsin, assisted by the Bureau of

Soils of the U. S. Department of Agriculture. An act passed by the last legislature provides that a soil survey and a soil map of the state be made to ascertain the character and fertility of the developed and undeveloped soils of the state, the extent and practicability of drainage of swamp and wet lands and the means for conserving and increasing the fertility of the soils. The sum of $10,000 annually is appropriated for the next two years for this work.

ACCORDING to the London *Times* an ascertained commercial value of £4 per milligram (equivalent to £114,000 per ounce) has been placed upon radium by a contract just entered into between the British Metalliferous Mines (Limited) and Lord Iveagh and Sir Ernest Cassel for the supply of 7½ grams (rather more than a quarter of an ounce) of pure radium bromide. This very large order for radium will be supplied from the above named company's mine near Grampound Road in Cornwall. In the short history of radium there has never hitherto been known any greater order than a gram. The first recorded order on a large scale will therefore be supplied from the British source from which several of the smaller orders have already been supplied. Messrs. Buchler and Co., of Brunswick, will produce the radium from the Cornish pitchblende under the superintendence of Professor Giesel, their chief chemist. The 7½ grams of radium referred to are to be presented by Lord Iveagh and Sir Ernest Cassel to the Radium Institute, to the formation of which they have already contributed very large funds. The Radium Institute, which will be under the surgical direction of Sir Frederick Treves, is expected to be ready to receive patients suffering from cancer about the end of the present year.

UNIVERSITY AND EDUCATIONAL NEWS

M. HENRY DEUTSCH has given 500,000 francs, and promises in addition an annual grant of 15,000 francs, towards the creation of an aerotechnical institute in the University of Paris. M. Basil Zakaroff has given 700,000 francs for the foundation of a chair of aviation in the faculty of sciences of the university.

A COLLEGE of mining engineering has been established at the University of Illinois. The Western Society of Engineers was instrumental in inducing the legislature to make the necessary appropriations. A committee for that purpose composed of F. A. Delano, Bion J. Arnold, John M. Ewen, Isham Randolph, Robert W. Hunt and A. Bement was appointed by the society.

AT the summer school of Columbia University there are about 1,930 students, about 400 more than were registered last year. In 1908 registration was 1,532, in 1907, 1,200, in 1906 1,000. The 1909 registration does not include the thirty medical students who are attending lectures, nor the 300 undergraduates who are taking the regular summer engineering courses at Camp Columbia, Washington, Conn.

THE College of Agriculture of the University of Wisconsin has established a department of agricultural economics in charge of Professor Henry C. Taylor.

THE following appointments have been made in the medical department of Cornell University: Dr. Frank Sherman Meara, professor of therapeutics and clinical medicine; Dr. Charles N. B. Camac, professor of clinical medicine; Dr. William J. Elser, professor of bacteriology; Dr. John A. Hartwell, professor of clinical surgery; Dr. William B. Coley, professor of clinical surgery; Dr. Silas P. Beebe, assistant professor of experimental therapeutics, and Dr. John R. Murlin, assistant professor of physiology.

DR. RALPH S. MINOR, professor of physics at the University of Nevada, has accepted an associate professorship of physics in charge of the lower division work at the University of California. The position in Nevada has been filled by the appointment of Professor Leon W. Hartman who, for the last four years, has been associate professor of physics in charge of the department at the University of Utah.

Dr. W. H. Sheldon, preceptor of philosophy at Princeton University, has been elected professor of philosophy at Dartmouth College.

Dr. Hardee Chambliss, of the research staff of the General Chemical Company, New York, has accepted the professorship of chemistry in the Oklahoma Agricultural and Mechanical College at Stillwater, Okla.

Mr. Benjamin F. Lutman, assistant in botany at the University of Wisconsin, has been appointed assistant botanist in the Agricultural College of the University of Vermont.

Dr. J. Eliot Coit, of the University of Arizona, has accepted the assistant professorship of pomology in the University of California.

In the department of zoology at Northwestern University, Dr. E. H. Harper has been promoted to an assistant professorship and Charles S. Mead, Ph.D. (Columbia), has been appointed instructor in zoology.

Professor John Cox has retired after nineteen years as Macdonald professor of physics in McGill University and first director of the Macdonald Physics Building. Professor H. T. Barnes has been appointed director and Professor H. A. Wilson, F.R.S., has been appointed Macdonald professor of physics. Dr. H. L. Brown has been appointed assistant professor of physics, Mr. F. H. Day and Mr. W. R. Gillis, lecturers in physics, Mr. A. L. Dickieson, Mr. N. E. Wheeler and Mr. A. G. Hatcher, demonstrators in physics.

In the Queen's University of Belfast appointments have been made as follows: professor of botany, Mr. D. T. Gwynne-Vaughan; lecturer in organic chemistry, Dr. A. W. Stewart; lecturer in physics, Dr. Robert Jack; lecturer in bio-chemistry, Dr. J. A. Milroy; lecturer in geology and geography, Dr. A. R. Dwerryhouse; lecturer on hygiene, Dr. W. James Wilson.

Dr. G. S. West has been appointed to the chair of botany and vegetable physiology in the University of Birmingham, rendered vacant by the retirement of Professor Hillhouse.

DISCUSSION AND CORRESPONDENCE

REMARKS ON RECENT CONTRIBUTIONS TO COSMOGONY

To the Editor of Science: In your issue of May 28 is a letter by T. J. J. See, ostensibly demanding "fair play and toleration" in the consideration of current contributions to science, but clearly written for the purpose of exploiting some of his own recent writings. In this letter, notwithstanding the implications of its caption, he takes occasion to characterize the work of Professor Chamberlin and myself as "inconsistent and purely destructive," and says:

> If Professor Blackwelder will study my last paper carefully, and the work now in press, when it appears, he will find that most of the recent speculations on cosmogony are not worth the paper they are written on; and yet some of them have been published by the *Astrophysical Journal* and the Carnegie Institution.

He also modestly states:

> It is only fair to say that no constructive results of consistent character had been reached on this subject till my own investigation was completed last year. . . . As I have worked on this subject uninterruptedly for twenty-five years, I am prepared to speak with some degree of authority.

Because of these extravagant pretensions and the fact that a majority of the readers of Science, being unfamiliar with the details of recent developments in this subject, will not credit any one with having the monumental nerve to put forward such claims without there being some basis for them, I beg the privilege of taking enough space to state briefly the facts relating to this matter.

The well-known nebular hypothesis was put forward briefly by Laplace, in 1796, at the end of a work on popular astronomy. Its simplicity and attractiveness, as well as the great name of its author, soon gained for it wide acceptance among scientific men. It satisfied those racial instincts for an explanation of the origin of things which gave rise to the cosmogonies of the ancients; and in stirring the emotions, the majestic sweep of events which

it described took the place of the heroic deeds celebrated in their epics. But its greatest value was in making, in the first half of the nineteenth century, a foundation for the development of geological theories respecting the age and evolution of the earth, and these theories, in turn, were important factors in Darwin's elaboration of his "Origin of Species."

The next important step in cosmogony was Helmholtz's contraction theory of the heat of the sun, published in 1854, which not only was not contradictory to the Laplacian theory, but was generally supposed to be a proof of its correctness.

In the latter half of the nineteenth century the Laplacian theory was supplemented by the consideration of some factors originally omitted, chiefly by Roche and Sir George Darwin, and some objections were urged against it, chiefly by Babinet and Faye. But the writings of practically all astronomers show that it was generally accepted without fundamental modifications. For example, Sir George Darwin in his classical researches on tidal evolution frankly stated that he accepted it in its main outlines; and in 1886 C. Wolf, of the Paris Observatory, reprinted in book form a series of articles appearing earlier in *Bulletin Astronomique,* Vols. I. and II., which clearly supported this theory. In the preface to this volume we read:

> Mon principal but, en écrivant ces articles, était de montrer que la théorie de Laplace répond encore aujourd'hui le mieux possible aux conditions que l'on est en droit d'exiger d'une hypothèse cosmogonique.

In the late nineties Professor Chamberlin in studying the earth's atmosphere, and particularly its origin and history, became skeptical of the soundness of the Laplacian theory; and simultaneously some of its weaknesses were forced on me while considering it in my classes in descriptive astronomy. Toward the end of 1899 we had several conferences on the question of its correctness, and as a result of these discussions we decided to test it, first as to its agreement with the facts established by observations, and secondly as to its self-consistency. The results of these inquiries are contained in a paper published by Professor Chamberlin in the *Journal of Geology,* February–March, 1900, and in one by myself in the *Astrophysical Journal,* March, 1900. It is well known that the conclusions reached in these papers seemed to us so adverse to the theory as to compel us to reject it as being no longer a satisfactory hypothesis; and since that time many astronomers have placed themselves on record as being in agreement with us.

Immediately after the publication of these papers constructive work was begun, chiefly by Professor Chamberlin. The first account of the new hypothesis which was developed was published by Professor Chamberlin in Year Book No. 3 of the Carnegie Institution, pp. 208–253 (1904), and another was published by myself in the *Astrophysical Journal,* Vol. 22, pp. 165–181 (1905). In Chamberlin and Salisbury's "Geology," Vol. 2, pp. 38–81 (1906), under the title of The Planetesimal Hypothesis, Professor Chamberlin gives an extensive account of the proposed theory. Some of the subheadings are: Subvarieties of the Hypothesis, The Hypothetical Origin of the Solar Nebula, The Contingencies of Stellar Collision, The Contingencies of Close Approach, The Special Consequences of Close Approach, The Acquisition of Rotatory Motion, The Result a Spiral Nebula, The Assigned Nebular Origin not Vital, The Evolution of the Nebula into Planets, The Part Played by Ellipticity of Orbit, The Evolution of Circularity, The Time Involved, The Bearing of the Mode of Accretion on the Direction of Planetary Rotation, The Spacing-out of the Planets, . . . He closes the chapter with the following summary:

> The planetesimal hypothesis thus assumes that the solar system was derived from a nebula of the most common type, the spiral, and that the matter of this parent nebula was in a finely divided solid or liquid state before aggregation, in harmony with the continuous spectra of spiral nebulæ. It regards the knots of the nebula as the nuclei of the future planets, and the nebulous

haze as matter to be added to the nuclei to form the planets. It assumes that both the knots and particles of the nebulous haze moved about the central mass in elliptical orbits of considerable, but not excessive, eccentricity. It postulates a simple mode of origin of the nebula connected with the not improbable event of a close approach of the ancestral sun to another large body, but the main hypothesis is not dependent on this postulate.

It assigns the gathering-in of the planetesimals to the crossing of the elliptical orbits in the course of their inevitable shiftings. Out of this process and its antecedents, it develops consistent views of the requisite distribution of mass and momentum, of the spacing-out of the planets, of their directions of rotation, of their variations of mass, of their varying densities, and of other peculiarities.

It deduces a relatively slow growth of the earth, with a rising internal temperature developed in the central parts and creeping outward. With such a mode of growth, the stages of the earth's early history necessarily depart widely from those postulated by the Laplacian and the meteoritic hypotheses. These stages now claim our attention.

In my "Introduction to Astronomy," pp. 463–487 (1906), I have discussed the same theory under the title of The Spiral Nebula Hypothesis. Some of the headings of the articles in this section are: Hypotheses Respecting the Antecedents of our Present System, A Possible Origin of Spiral Nebulas, The Development of the Solar System from a Spiral Nebula, The Origin of Planets, The Origin of Satellites, The Planes of the Planetary Orbits, Rotation and Equatorial Acceleration of the Sun, The Small Eccentricities of the Planetary Orbits, The Rotations of the Planets, The Eccentricities of the Satellite Orbits, The Moment of Momentum of the System, The Evolution of the Planets, The Age of the Solar System, The Future of the System. . . . The chapter is closed with the following summary:

The first word should be one of warning that the theory which has been sketched briefly should not be accepted as final. There are many points where quantitative results must be obtained and compared with our actual system. There may be many modifications of it possible and necessary. For example, the genesis of spiral nebulas may be different from that postulated above.

The hypothesis of an original spiral nebula is suggested by recent photographs of nebulas as well as by the system itself. The conditions which are supposed to have given rise to the spiral nebula seem most reasonable in view of the motions of the stars. The development of a spiral nebula by the near approach of two suns seems to be a necessary consequence, though this point needs further elaboration. The development of some such a system as ours from a small spiral nebula of the type considered seems to be inevitable. So far as the details have been worked out nothing directly contradictory to the theory, or even seriously questioning it, has been found, while it explains admirably all the main features of the system. It can be safely said that, at present, this hypothesis satisfies all the requirements of a successful theory much better than any previous one.

Since the publication of these books the work of elaborating and testing the theory has been carried forward by both Professor Chamberlin and myself, and a part of the results obtained have been published by the Carnegie Institution.

The alleged twenty-five years of uninterrupted work upon the evolution of the solar system by See have resulted only in the following papers so far as I am aware: (1) "Significance of the Spiral Nebulæ," *Popular Astronomy*, pp. 614–616 (December, 1906); (2) "On the Cause of the Remarkable Circularity of the Orbits of the Planets and Satellites and on the Origin of the Planetary System," *Astronomische Nachrichten*, No. 4308 (February 24, 1909), the same paper printed in *Popular Astronomy*, May, 1909, and at least the substance of the same paper communicated by its author to the Chicago *Record-Herald* early in 1909.

In the paper in *Popular Astronomy*, written over the date October 23, 1906, See makes the following statements:

For a number of years the writer has given consideration to the probable nature of the spiral nebulæ, and their importance has been considerably increased by photographs obtained by Roberts and Keeler, and more recently at the Yerkes Observatory. Certain speculations have been in-

dulged in which implied that the spiral nebulæ are true nebulæ condensing into systems of stars. Though this premature and unauthorized line of thought has been extensively exploited, and even given place in one treatise on geology, it has always seemed to the writer quite unsound. I have consistently held that so far we do not know the true character of the spiral nebulæ, and this position is amply justified by the penetrating remarks of M. Poincaré. Whether the spiral nebulæ are other Milky Ways, as suggested by the illustrious French geometer, time alone can tell; and it may be several centuries before this question can be satisfactorily settled. Meanwhile the exploitation of the spiral form as typical of nebular development is certainly misleading, for, as Poincaré points out, there is no proof that these spirals are true gaseous nebulæ.

The speculations on spiral nebulæ have been decidedly overdone, and it is time to call a halt. There is not the slightest probability that our solar system was ever a part of a spiral nebula, and such a suggestion is simply misleading and mischievous. The great circularity of the planetary orbits shows the absurdity of such an hypothesis. . . . Least of all can we expect any light from the much exploited spiral nebulæ, which as M. Poincaré justly remarks, may be other galaxies. It is time, therefore, to drop such spirals from our text-books, or to candidly admit that we are quite in the dark as to their true significance.

In the last paper of See recently published in the *Astronomische Nachrichten* and several other places we read:

The solar system was formed from a spiral nebula, revolving and slowly coiling up under mechanical conditions which were essentially free from hydrostatic pressure. And spiral nebulæ themselves arise from the meeting of two or more streams of cosmical dust. The whole system of particles has a sensible moment of momentum about some axis, and thus it begins to whirl about a central point, and gives rise to a vortex. In the actual universe the spiral nebulæ are to be counted by the million, and it is evident that they all arise from the automatic winding up of streams of cosmical dust, under the attraction of their mutual gravitation. . . . When the nebula rotates and the coils wind up in such a way as to leave open spaces between the coils, or at least freedom from sensible hydrostatic pressure, the usual result is the development of a system made up of small bodies, such as the planets compared to the greatly preponderant sun, or the satellites compared to the much greater planetary masses which control their motions. In the solar system where the conditions are accurately known this is proved to have occurred; and it was repeated so many times always with uniform results giving a large central mass and small attendant bodies that the general law for this condition is clearly established.

Thus we see the variety of "consistent" conclusions recently reached by the twenty-five years of uninterrupted work on this subject.

At the end of this paper See admits its value in the following modest terms:

It has seemed advisable to call attention to the cause of the roundness of the orbits of the planets and satellites, because it appears likely that the criteria now introduced may go far towards clearing up the mystery which has always surrounded the origin of our solar system.

In See's paper there are only two points of divergence from the ideas fully developed by Professor Chamberlin and myself. The first is that spiral nebulas have their origin in "the meeting of two or more streams of cosmical dust." The second is that satellites are captured bodies. This latter view has been advanced by many amateurs and a few astronomers. It was considered in my writings quoted above, and rejected for what seemed to me to be good reasons. The resisting medium on which so much stress is laid is simply a special case of the collisions of *any* character considered by Professor Chamberlin and myself.

The quotations above are sufficient to remove the clouds which See's pretensions of long study of, and valuable contributions to, this subject might raise in the minds of those not particularly familiar with the history of recent developments in cosmogony. I wish to point out that notwithstanding the evidence furnished by his 1906 paper of his familiarity with our work, and in spite of the fact that at his request I furnished him reprints of my papers several months in advance of his recent publication, there is in it no direct or indirect reference to Professor

Chamberlin or myself. Ordinarily such conduct justifies the use of strong terms in characterizing it, but in the present case I believe astronomers and others who are familiar with the situation will fully agree with me that these aberrations are more deserving of pity than of censure. F. R. MOULTON

June 10, 1909

COMMUNICATING WITH MARS

TO THE EDITOR OF SCIENCE: In view of the recent proposals for opening communication with the planet Mars, as reproduced by the European press from American newspapers (with accompanying portraits), no truly patriotic American can fail to feel a thrill of pride and exultation at the thought that it his country that is solving this great cosmic problem. It is time to sound the alarm, however, for there are indications that an attempt will be made to rob us of the honor after all. A distinguished French astronomer has recently published a letter on the subject, in which, while giving a small measure of approval to the American projects, he broadly intimates that the last word has not been said. The Germans are keeping very quiet, but it is rumored that Count Zeppelin is thinking, and in commercial and manufacturing circles there is great though silent activity in the direction of trying to ascertain in advance just what articles now "made in Germany" are likely to be most in demand among the inhabitants of Mars when once communication is opened. Assuming that the planet is correctly named (and it has borne the name for hundreds of years without protest), the great Krupp establishment is looking for a practical monopoly of trade, and to meet the expected emergency it has taken options on all the land adjacent to the present planet. Their engineers are known to entertain the opinion that it will be a comparatively simple matter to send to Mars a 14-inch 70 foot gun, first, of course, hermetically sealing it in the aluminum cylinder. If it should not reach the exact spot where it is wanted it can readily be transported anywhere by canal boat.

Having all this information, which has only recently come to me, I have decided to protect American interests by making premature publication of my own scheme for signaling to our celestial neighbor, which, for efficiency, simplicity of arrangement and ease of operation altogether surpasses, I think, all will admit, anything hitherto before the public. It is well known, even among astronomers, that as the orbit of the earth lies between the sun and that of the planet Mars, the dark side of the earth must, at regular intervals and for considerable periods of time, be turned toward Mars.

A hole through the earth would, at this time, allow the passage of a beam of sunlight, the intelligent interruption of which could be made to appear as a series of signals, using the Morse (E. S.) code or any other that might be chosen.

That is all; the problem is solved in this simple way.

One can readily understand how the system might be also put in operation on the moon, if the lunatics would only bore a hole through which the sun might shine when the dark side of the moon was toward us and then arrange a device for cutting off this beam of light at will. For our immediate purpose of wigwagging to Mars such a hole must necessarily be several miles in diameter. Although some minor difficulties in the way of the execution of this plan remain to be overcome, many of the details are already settled, including the selection of the spot where such an opening might best be made in the interests of mankind generally. T. C. M.

DRESDEN, GERMANY,
May, 1909

P. S. I regret that I have no portrait to send with this.

"TYPHOID MARY"

MUCH has appeared in the press of late concerning the unfortunate woman who for two years past has been held a prisoner upon North Brothers Island by order of the board of health. On June 29 she appeared before Supreme Court Justice Giegerich on a writ of habeas corpus, sued out by her attorney to obtain her release. Judging from the evidence,

we all know that Mary is a "typhoid carrier," and a dangerous one by reason of her occupation as a cook; but she is only one among many such "carriers" and it is scarcely justice to place upon her alone the burden that should be shared by her entire class.

Of all those who recover from typhoid fever something like four per cent. carry about with them the germs of the disease for long periods of time. They are "carriers" in fact, and can, like Mary, become centers for secondary infection. There are at the present moment probably 560 such persons in the state of New York, representing four per cent. of the 14,000 cases of typhoid fever occurring during the past year. How many must be added to that number to allow for the "hold-overs" coming down from previous years it would be hard to guess. Others will be added during the year to come.

We can not keep in detention all these people, then why single out and imprison one.

Typhoid carriers are dangerous when they are possessed of uncleanly personal habits, and they become more so when their occupations have to do with the preparation of food.

It would be eminently wise to instruct a "carrier" as to the danger lurking in human dejecta and to insist upon the necessity for great personal cleanliness. It might be also well for the authorities to direct that such a person should not be engaged in the preparation of food; but beyond "education" and an order for "change of occupation" it is scarcely practical or fair to go.

W. P. Mason
Rensselaer Polytechnic Institute,
July 1, 1909

QUOTATIONS

MR. LATHAM'S AEROPLANE

After a comparatively short training, Mr. Hubert Latham has brought the Antoinette monoplane from obscurity into serious rivalry with the Wright machine as regards duration of flight, while it is easily superior in speed. He has also shown that it can be flown in windy weather, and the ease with which he controls it quite upsets the theory held by the bi-planists that the monoplane is exceedingly difficult to manage. Nevertheless, when the experience of Mr. Latham is placed alongside that of the many other monoplanists, who so far have not been particularly successful, the point is demonstrated that the human element counts for much. It would appear that Mr. Latham is something of a genius in navigating aerial machines.

The Antoinette monoplane, which is designed by M. Levavasseur, consists of a central skiff-like body, from each side of which a main plane springs at a slight upward tilt. The single propeller is mounted in front of the central body, and close behind is the motor. In a well to the rear of this the pilot is comfortably situated, his position allowing him a clear look-out, and affording a certain degree of protection not noticeable in other machines. Indeed, Mr. Latham claims that he is very safe from injury in this machine, being well protected by the planes and the body of the vessel.

At the rear of the main body are vertical equalizing fins, two vertical rudders, and a horizontal elevator for giving upward or downward direction. The lines of the body are very clean, the total bearing surface is remarkably small, and there is an absence of the many stays and members which, in the biplane especially, lead to increased head resistance and consequent loss of speed. At the rear end of each main plane is a flexible extension, which can be given a varying angle of incidence for purposes of stability.

The under-frame is a clever piece of work. The chassis rests on two wheels placed close together, and a forward extension of this frame takes the form of a runner, which is designed to receive the first shock of landing and thus save the wheels from buckling strains. The combination of sledge runner and wheels in the Antoinette enables the aeroplane to be started without the use of extraneous mechanism, whilst it allows landing to be effected at speeds which would smash any ordinary wheel.

The control of the Antoinette machine is by means of side wheels, those at one side

governing the warping planes, and at the other controlling the elevator. There is another controlling agent for the side rudders, and yet another for the fuel supply to the engine. The controlling mechanism is grouped in such a manner as to afford easy mastery over them, and Mr. Latham has shown that he can travel in the air without both hands being busily occupied.

The eight cylinders of the engine are grouped in two banks of four, arranged in V fashion; petrol is injected direct on to the inlet valves, no carburetter being employed. The fuel supply is governed by a pump of variable throw, and the necessary air is supplied through air pipes leading to the valves. The water-cooling arrangement on the Antoinette engine is also unique. Very little water is employed, and it is quickly turned into steam. This is carried away to an effective condenser, the tubes of which line the side of the main body. The condensed water is taken by a pump to the water tank, and thence is pumped to the cylinder jackets. This engine gives one horse power for about every three pounds of weight.—The London *Times*.

SCIENTIFIC BOOKS

Revision of the Mice of the American Genus Peromyscus. By WILFRED H. OSGOOD, Assistant, Biological Survey. Prepared under the direction of C. HART MERRIAM, Chief of Biological Survey, Department of Agriculture. North American Fauna, No. 28. Washington, Government Printing Office. April 17, 1909. Pp. 1–280, text-figs. 1–12, pl. I.–VIII.

Mammalogists have awaited with eagerness the long-delayed publication of Mr. Osgood's monograph of the genus *Peromyscus*. The work consists of a systematic study of all the members of the genus, and includes keys for the identification of the various forms, together with the necessary illustrations, and maps showing the geographical distribution of the species.

Plate I. (colored) illustrates the distribution of the species and subspecies of the *Peromyscus maniculatus* group, plates II. to VIII. depicting the cranial and dental characters of prominent species of the genus, and text-figures 1 to 12 portraying the geographical distribution of the various species and groups.

As stated by the author:

> The American genus *Peromyscus*, including the so-called wood mice, deer mice, vesper mice or white-footed mice, has needed revision for many years. One or more of its numerous species and subspecies inhabit almost every part of North America; moreover, these mice, wherever found, are among the most abundant of small mammals. The group, therefore, is of such importance that it must be dealt with in every work on North American mammals, whether pertaining to classification, geographic distribution or economic relations.

It is now about seven years since Mr. Osgood undertook the revision of this great genus of American murines, which has just been brought to a most satisfactory conclusion. During this time, in spite of many interruptions, he has examined all of the specimens of the genus *Peromyscus* in the great museums of America and in numerous private collections, in the British Museum, and the museums of Europe, having unearthed *Peromyscus* types in the museums of Munich and Zurich.

In 1891, Dr. J. A. Allen, after discussing certain species of *Peromyscus*, made the following statement:

> But the time has not yet come for a satisfactory revision of the group, to attempt which at least 20,000 specimens are requisite, collected so as to fully represent the seasonal phases of pelage obtaining at hundreds of more or less widely separated localities.

Mr. Osgood remarks:

> These conditions are now realized to the fullest degree, for the number of specimens examined in the present revision exceeds 27,000. The majority of these are contained in the extensive collection of the Biological Survey, which, under the direction of Dr. C. Hart Merriam, has been built up with special reference to the various life areas of North America, and without which no satisfactory study of this group would now be possible. . . . This material includes all the types, both of valid forms and of synonyms, known to be in existence.

In almost all cases in which no types exist, good series of topotypes, or specimens from near the type localities, have been available.

Mr. Osgood's study of this wealth of material has resulted in a definite expression of the characters of the species and geographic forms of *Peromyscus*, almost the last important genus of North American mammals which has remained to be systematized by a trained mammalogist in possession of an abundance of well-prepared and carefully-selected specimens.

The chaotic condition of *Peromyscus* can best be illustrated by a quotation from the author's introduction, under the caption of "History and Nomenclature":

In fact, no fewer than 167 names for new or supposed new forms of *Peromyscus* have been proposed since 1885. Add to this the 14 contained in the present paper, and the total of 181 is reached. . . . Of the 167 names [excluding those proposed by the author in the present monograph] for supposed new forms of *Peromyscus* proposed since 1885, 58, practically one third, are of more than doubtful status and are here treated as synonyms.

The subject matter is presented under the following headings: Introduction, Material, History and Nomenclature, Variation, Intergradation, Pelages, Color Descriptions, Measurements, Keys, Records of Specimens, Subgenera, Habits and Economic Status, List of Species and Subspecies with Type Localities, New Subspecies, Genus *Peromyscus*, Subgenus *Peromyscus*, Subgenus *Megadontomys*, Subgenus *Ochrotomys*, Subgenus *Podomys*, Subgenus *Haplomylomys*, Subgenus *Baiomys* and Table of Measurements.

The paper, throughout, has the advantage of being written in simple language adapted to the use of ordinary workers, to whom hints of practical value are being continually thrown out, the author happily having adopted the principle of helping rather than impressing his readers. There is also a pleasing element of fairness, and impartial weighing of evidence, when dealing with the writings of previous authors, which reflects the personality of the author.

The folded map (Plate I.) showing, in colors, the distribution and intergradation of the 39 subspecies of *Peromyscus maniculatus* must excite the astonishment and delight of mammalogists, inasmuch as showing that, at last, we have acquired enough specimens of one large and complex group to illustrate its interrelations. Many of the named forms which Mr. Osgood has placed in synonymy represent the wavy lines, which, in his colored diagram, show "areas of intergradation." Who, years ago, could have imagined that *Peromyscus canadensis* Miller (= *Peromyscus maniculatus gracilis*) and *Peromyscus pallidus* Allen could possibly be proved to be conspecific forms, actually intergrading through the subspecies *maniculatus, arcticus, nebrascensis, luteus* and *bairdi*? Again, in 1890, the reviewer described *arcticus* as a subspecies of *leucopus*, and, the same year, Merriam ventured to separate *rufinus* from *leucopus* as a subspecies. Now we know that these forms are distinct from the species *leucopus* and belong to the then unrecognized species *maniculatus*. This knowledge is due to the possession of adequate and carefully-studied material.

An important feature of Mr. Osgood's monograph is the wonderful key to *Peromyscus*, which is one of the best of its kind. With it, one can open the *Peromyscus* cage with the certainty that the particular white-stockinged little mouse wanted will prance out at the simple turn of the wrist. One can not fail to admire the ingenious construction of this key that actually works the combination.

As a reviewer, I suppose I ought, in self-defense, to find some fault with a monographer who has had the temerity to relegate several forms described by myself to the category of synonyms; but I have not the disposition to find fault with a work of such practical utility and completeness, planned on uniform lines, and carried out to such a satisfactory conclusion. It is really straining a point when, for instance, I assert that, in my opinion, *Peromyscus eremicus arenicola* should have been recognized as a valid subspecies of the Eastern

Desert Tract; and when I expostulate at having my *Peromyscus boylii penicillatus* compared with "a series from the Franklin Mountains near the type locality [of *penicillatus*]," which mountains lie wholly without the eastern desert differentiation tract, as defined in my mammals of the Mexican boundary line; also, *Peromyscus boylii pinalis* is, in my estimation, the Transition, zonal form of *P. b. rowleyi* of the Upper Sonoran Zone; but, on the whole, I am convinced that mammalogists will regard Mr. Osgood's conservatism, in the matter of recognizing subspecies, with favor. I am still of the opinion that Dr. True's subgenus *Baiomys* should be raised to the rank of a genus.

In conclusion, I take off my hat, and make a low bow to Mr. Osgood, as the author of one of the best papers dealing with North American mammals.

EDGAR A. MEARNS

The General Character of the Proteins. By S. B. SCHRYVER, Ph.D., D.Sc., Lecturer on Physiological Chemistry, University College, London. London, New York, Bombay and Calcutta, Longmans, Green and Co. 1909. Pp. x + 86.

A review of progress in any field of study can serve a diversity of purposes. As a summary of discoveries made it brings an up-to-date appreciation of current knowledge and makes it ready for convenient reference; and if the résumé has been critically prepared, it may fulfill the almost equally important function of pointing out the limitations of our experience in any domain and the problems awaiting solution. In the latter respect especially, Dr. Schryver's monograph deserves commendation. The author has taken pains to emphasize how inadequate are the more familiar characterizations of the proteins and how imperfect the criteria of purity, individuality, etc., which are currently applied.

To those less familiar with the extensive literature on this subject it may come as a surprise to learn that the time-honored methods of isolation and identification of proteins employed in every biochemical laboratory are at best extremely defective and unreliable. The investigator will find the refreshing suggestion that the contributions of modern colloid chemistry are far from adequate for an elucidation of the properties of the proteins; so that for some time to come, at any rate, "reliance will have to be placed chiefly on the purely chemical methods for the identification of the proteins."

The monograph is grouped into a review of: (1) The physical properties of the proteins, (2) their general chemical characters, and (3) a very brief reference to the biological methods of identifying proteins. It thus supplements Professor Aders Plimmer's earlier review of the chemical constitution of these compounds.

Among the diverse topics under discussion, that of the behavior of proteins towards acids and bases and the question of salt formation by them has, very properly, received a proportionately large share of attention from the author. This is most timely; for a more profound explanation of these phenomena will go far, we are confident, to explain many peculiarities of protein behavior. The limitation of cryoscopic methods applied to proteins in the present state of our knowledge of colloids is pointed out. The hope is expressed that some elaboration of quantitative reactions may be effected, so that the proteins may be characterized thereby. This is approached most nearly in the constants for the distribution of nitrogen in the molecule ("Hausmann numbers"). It is not unlikely that a tyrosine factor (Millar), or an amino-index (Brown, Sörensen) may give us useful data comparable, as Dr. Schryver suggests, with the constants employed in fat analysis.

In the discussion of the "salting out" of proteins the early work of Dénis is given a recognition which most writers overlook. The expression "prosthetic group" usually ascribed to Kossel is attributed to Hoppe Seyler (pp. 3 and 32). In the discussion of methods of crystallizing egg albumin, the experience of T. B. Osborne[1] and other investigators is overlooked. A similar comment

[1] *Jour. Amer. Chem. Soc.*, 1899, XXI.

might be made on the chapter concerning sulfur in proteins (p. 36).[2] The author's surmise (p. 32) that the Millon's reaction given by gelatin may be due to an impurity is scarcely justified since the work of Pickering, Van Name and Mörner.

The appended bibliography is useful, although by no means complete.

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SPECIAL ARTICLES

NOTES ON SOME SALAMANDERS AND LIZARDS OF NORTH GEORGIA

THE following salamanders and lizards were observed at Thompson's Mills, Gwinnett County, north Georgia, during the summer of 1908.

Among the batrachians of the order Urodela, the following salamanders were found.

Plethodon glutinosus (Green). This is a thick, stout-bodied, nearly cylindrical species, and is capable of secreting a viscid, milky juice, which has given it the name of the sticky salamander. Specimens found at Thompson's Mills, Ga., in life, were dark bluish slate above, lighter or paler on the belly. The back and head were thinly sprinkled with tiny, grayish-white dots, with a few whitish or grayish dots beneath, mainly on the throat. The sides were mottled with grayish, forming an almost continuous band to the end of the tail. Length 5½ inches. Several specimens of this salamander were found at the above locality, all beneath logs and the bark of decayed, fallen trees, in shady, damp woods. This salamander is terrestrial in its habits, and occurs in the extreme north as well as throughout the south. It is not uncommon at Thompson's Mills, Ga.

The red salamander (*Spelerpes ruber* Daudin). At maturity this is a thick, plump, short-bodied species, with small, weak legs. Its skin is clear, smooth, without glands, but besprinkled with shallow pits.

[2] Cf. *Jour. Amer. Chem. Soc.*, 1902, XXIV., 140.

The specimens found at Thompson's Mills were 4½ to 5 inches long. In living specimens the coloration above was brick-red, very much paler (or pinkish) on the belly. The back and head were thickly and uniformly sprinkled with black dots about the size of pinheads. Along the sides these dots became much smaller and more scattered, and were completely wanting along a line drawn along the sides connecting the outer attachment of the legs. The legs were of the same color as the back, and finely dotted with black.

This pretty salamander also ranges over the eastern portion of the country. At Thompson's Mills, I found only two individuals, both beneath rotten logs in hilly woods. This species is of more aquatic habits, which probably accounts for the fact that an examination of hundreds of rotten stumps and logs in the upland woods yielded only two specimens.

Spelerpes gutto-lineatus (Holbrook). This is a very pretty, slender and elongated animal, with a slender, compressed tail, longer than the body. Living individuals which I have found at Thompson's Mills showed the coloration described as follows. Beginning just back of a line joining the eyes, a narrow, black stripe extended along the back bone, to a point just behind the legs where it terminated abruptly. Bordering this stripe on either side, is a light grayish-brown stripe beginning at the tip of the nose and extending just above the eyes. These light, dorsal stripes unite on the tail where the black, spinal stripe terminates. On each side beginning from the eye, another narrow, black stripe extended to the tip of the tail, narrowing in proportion as the tail becomes more attenuated. This lateral black stripe was spotted with whitish marks, and its lower edge outlined with white. The belly was evenly and thickly mottled with yellowish and light gray. I found only two specimens of this salamander at Thompson's Mills, both under a log in wet ground near a brook. Their lengths were 7 inches and 5¾ inches, respectively. This salamander is mostly southern in its range.

Desmognathus fusca. This small, aquatic salamander occurs in the brooks at Thompson's Mills. In its coloration, this species shows great variability. In March of the season 1908, I found some small individuals in a brook at the above locality.

Among the lacertilia, the following lizards were found at Thompson's Mills.

The blue-tailed skink (*Eumeces fasciatus* Linnæus) is exceedingly common at the above locality and elsewhere in the south. In every field and wood, they may be found basking in the sun or running with great rapidity over the ground, until they seem only a streak, hence the common name streak-field. I have very frequently captured this skink under the bark of fallen trees, and in decayed stumps. As the sun goes down, these creatures seek shelter in stumps and logs, and stone-heaps, etc., where they may be readily found. During the early part of the summer, at the egg-laying period, these pretty lizards were frequently to be found in hollow stumps and logs. Under date of June 13, 1908, I find a record in my field journal, of a male and a female skink together with seven eggs, in a cavity under the bark of a rotten log. The eggs were lying in a group on the decayed wood beneath the bark, and showed the following dimensions:

	Length, Cm.	Width, Mm.
1	1.35	8.5
2	1.25	9.5
3	1.35	9.0
4	1.20	9.0
5	1.30	8.5
6	1.25	8.0
7	1.30	9.0

These eggs were perfectly elliptical, with a white, tough membrane for a shell, and contained young lizards. I have frequently found this lizard in the crevices and hollows of dead trees a considerable distance from the ground. Captured, it tries very hard to escape, and will snap viciously at one's fingers, although it can do no injury. The coloration of this species is very brilliant, with a high luster. The older males are commonly known as scorpions, and are considered extremely poisonous.

Sceloporus undulatus (Latreille). This common lizard is familiar to nearly every one throughout the south. At Thompson's Mills, it is very abundant in all wooded upland situations, and loves to bask in the hot sun, stretched out lazily at full length on a fence-rail or rock. Disturbed, it runs with great agility, usually up the nearest tree. On the tree-trunk, it moves so that it keeps the tree between itself and the observer, as does a gray squirrel. Its coloration should be of very protective nature, as the dull-grayish and brownish markings very closely assimilate with the general grayish and brown colors of tree-trunks, lichen-covered rocks, etc. This gentle lizard when caught, makes little or no great effort to escape. I kept one for a considerable time on an upstairs porch of my dwelling at Thompson's Mills. Every day it came out from the vines and basked contentedly in the sun. This lizard feeds on all kinds of insects, including grubs, large grasshoppers, etc. I once witnessed one of these creatures attempting to capture a large grasshopper which had got among the grass and weeds in a thicket by the roadside. The grasshopper—one of the very large species—could not readily fly away on account of the grass and weeds, but dashed about, with the lizard following every movement, and in hot pursuit. To an observer witnessing this active chase, it would appear that this lizard must be able to see pretty well, although Dr. Abbott concluded that the vision of this lizard is not very acute. At another time, in the vicinity of Thompson's Mills, I came across one of these lizards, which scurried up a tree on my appearance. Something large and white was protruding from its mouth, causing the lizard to breathe in long, painful gasps. I killed the creature and found an enormous, hairy grub half swallowed head first. The grub was too large for the lizard to swallow, and could not be ejected, so that its mouth was forced wide open, and breathing rendered extremely difficult. At other times I have frequently watched these lizards snapping up very rapidly the tiny insects it met with on trees and logs.

Most of the specimens obtained were kindly identified for me by Dr. Stejneger, of the U. S. National Museum.

H. A. Allard

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SOCIETIES AND ACADEMIES

THE GEOLOGICAL SOCIETY OF WASHINGTON

The 220th meeting of the society was held at the Cosmos Club on Wednesday evening, May 12.

Regular Program

Significant Time-breaks in Coal Deposition: Mr. Geo. H. Ashley.

In a study of the results which were recently published in *Economic Geology*, it was found that one foot of bituminous coal, if deposited under present-day conditions, would require at least three hundred years for its laying down.

Considering the known variation in the thickness of single coal beds, the question arises as to whether it may not prove possible to use a coal bed as a measuring rod for the time of deposition of other beds in the coal measures. Thus, in the case of a bed 15 feet thick in one district and 18 inches in another, if the coal in each case were deposited at the same rate, the 15-foot bed required *at least* four thousand years longer than the 18-inch bed. Study was made to see if where the coal was thin there was a compensating thickening of the adjoining rocks. As far as the study was carried no such compensating thickening could be found. It was therefore assumed that in the cases examined the thin bed of coal represents approximately all of the deposit made at that point during the time required for the deposition of the thick bed near by. This resulted from either slow growth or time-breaks either in or just preceding or following the thin coal bed itself.

A study of the rate of deposition of certain peats in Europe leads to the conviction that in many cases the difference in thickness is due to difference in rate of deposition, while in other cases the difference would seem to be due to time-breaks or periods of non-deposition.

The evidence of these time-breaks may consist of "smooth partings," which, as in the Lower Block coal of Indiana, may locally show as unconformities between the under- and overlying beds, or of smooth partings which are represented in other districts by up to 40 feet of shale and sandstone, as in Coal IV. of Indiana. In other cases one or two inches of cannel coal or bone may be represented in an adjoining district by a thick parting, as in the Moshannon bed, west of Houtzdale. In some beds partings of clay, shale or sandstone, where they are known, are uniformly thin and regular. In other beds they will vary from one fourth inch up to 40 or 50 feet. In such cases the great thickness of the parting often suggests, even though it does not prove, a considerable time interval.

A study of the problem seems to indicate clearly that the elements of slow growth and of temporary non-deposition can not be eliminated from it, and that it would be scarcely right to say that the rocks forming a parting in the coal, or that a certain thickness of rocks above or below the coal, may have taken a certain number of years for their deposition, equivalent to the time represented by the difference in the thickness of the coal at that point and at the point of greatest thickness, multiplied by an assumed rate of deposition of the coal.

Cretaceous Geology of the Carolinas and Georgia: L. W. Stephenson.

The belt of Cretaceous deposits which, with certain interruptions, extends along the inner margin of the coastal plain from Marthas Vineyard, Mass., to Cairo, Ill., has its widest areal development in the region of southeastern North Carolina and northeastern South Carolina.

In North Carolina three Cretaceous divisions are recognized. The oldest of these is of lower Cretaceous age, and consists of about 275 feet of light-colored, coarse, generally compact or partially indurated, feldspathic, cross-bedded sands with inter-stratified lenses of massive more or less sandy clays. So far as known these materials are non-fossiliferous. The beds are separated from the overlying Cretaceous strata by an unconformity. Employing physical criteria, the division has been correlated approximately with the Patuxent formation of Virginia and Maryland. The name Cape Fear formation was proposed for this terrane by the writer in a paper entitled "Some Facts Relating to the Mesozoic Deposits of the Coastal Plain of North Carolina," which appeared in 1907.

The next younger division, which is of upper Cretaceous age, consists of 500 to 600 feet of dark to black lignitic, irregularly bedded and for the most part laminated, sands and clays, with interbedded marine lenses in the upper portion. As regards their structural relations the beds rest

unconformably upon the Cape Fear formation and are overlain conformably by strata of the next younger Cretaceous division and by non-conformable post-Cretaceous deposits. Fossil plants occur from the base to the top of the division, and towards the top invertebrates occur in marine lenses interbedded with the plant-bearing beds. Both the physical and paleontologic characters point to the approximate equivalency of the formation with the Magothy-Matawan series of New Jersey and with the combined plant-bearing Tuscaloosa beds, the Eutaw formation and the lower portion of the Ripley formation of Alabama. As regards more distant correlations the plants seem to indicate equivalency with the Woodbine division of Texas, the Dakota formation of the western interior, and the upper Cenomanian or Turonian of Europe, while the invertebrates, which show a close faunal relationship with the overlying younger division in North Carolina, point perhaps even more strongly to equivalency with the Taylor-Navarro series of Texas and the Montana series in the western interior, both of which occupy positions not only above the Woodbine and Dakota formations, respectively, but also above the still higher Colorado group representatives. There exists, therefore, a difference of opinion which with the present array of facts is irreconcilable; and the question of the correlation of the division with deposits outside of the Atlantic coast and eastern gulf regions must remain an open one until additional data are procured. In the paper previously mentioned the writer proposed the name Bladen formation to designate these beds.

The third and youngest division, also of upper Cretaceous age, consists of 700 to 900 feet of dark gray, more or less argillaceous and calcareous, marine sands and clays, conformably overlying the Bladen formation, and unconformably overlain by Tertiary and later deposits. The beds carry marine invertebrates indicating approximate equivalency with the Monmouth formation of New Jersey and with the upper Ripley beds of Alabama. Employing the same criteria, the division is correlated with the Navarro formation of Texas, the Montana series in the western interior, and the Senonian of Europe. The name Ripley formation was applied to this division by the writer in 1907, but owing to uncertainty which has arisen regarding the exact meaning of this term as employed in the gulf region it will probably have to be dropped, in which case the name Burches Ferry formation applied by Sloan to the southward continuation of the terrane can appropriately be employed in North Carolina.

In both South Carolina and Georgia equivalents of all three of the divisions occurring in North Carolina have been recognized, and their approximate areal distribution determined.

The Santa Maria Graphite Mines, Sonora, Mexico: Frank L. Hess.

The Santa Maria graphite mines which are owned by the United States Graphite Company, of Saginaw, Mich., are situated about twenty miles south and a little east of La Colorado, in central Sonora. The country rock is a metamorphosed sandstone, ranging in fineness from shaley material to conglomerates containing pebbles one and one half inch in diameter. Considerable andalusite in small crystals is developed in the sandstones. The rocks are probably of upper Triassic (Richmond) age. They are intruded by graphite which has been the metamorphosing agent. Intercalated with the sandstones are at least seven beds of graphite ranging in thickness up to 24 feet and standing at high angles. The rocks are considerably folded and the graphite beds show the effect of movement more than the enclosing sandstones, so that they are in places almost cut off through squeezing, while in other places they show thickening. The graphite beds are also intruded by granite dikes and in places granite forms the walls. The graphite is undoubtedly formed through the metamorphism of coal beds, which in other parts of the state are to be found in the form of coke, anthracite and bituminous coal. The graphite of the Santa Maria deposits is entirely amorphous and from the main vein averages 85 to 86 per cent. graphitic carbon. Specimens may be picked which carry 95 per cent. graphitic carbon.

The material is shipped to Saginaw, Michigan, for refining. A large part of the best pencils are made from this graphite. It is also used for a lubricant, foundry facings, etc.

At the 221st meeting of the society, held at the Cosmos Club on Wednesday evening, May 26, Mr. S. F. Emmons spoke informally on the Cobalt mining region.

Regular Program

Diopside and its Related Minerals: Arthur L. Day.

The formation of pure wollastonite from its component oxides, lime and silica, and its combination with magnesium metasilicate to form diopside, together with a record of the character

and stability of all the mixtures which result when one of the components is present in excess of the exact proportion required to form the mineral, establishes the practicability and effectiveness of physico-chemical methods in solving such questions as the order of crystallization from the magma and the stability of the crystalline products formed during the cooling to present temperatures. The relations between these minerals are nearly all eutectic, and when considered in connection with previous work on isomorphous mixtures, serve to illustrate the certainty with which such measurements upon rock-making minerals can be made and interpreted, their freedom from dependence on the personal judgment of the observer, the comprehensive way in which characteristic differences of physical form, as well as those of chemical composition, are taken into account, and the ready adaptability of the system to provide a more comprehensive classification of the mineral relations whenever a sufficient body of such measured data shall have been gathered.

The scope of the laboratory problem, that is, the immense domain within which these methods have now been successfully applied, is shown by the fact that these minerals were studied not only through all percentages of the components, but over the entire range of temperatures in which stable forms occur, either in the mineral compounds or their components—in all, a range of about 2,100 centigrade degrees.

Pure silica was found to possess three stable crystal forms: (1) α-quartz—stable at ordinary temperatures and up to 575° C.; (2) β-quartz—stable from 575° to 800°; (3) tridymite (cristobalite)—stable from 800° to the melting temperature (1,600°).

Pure lime has but one form which melts in the electric arc but is out of reach of accurate pyrometry.

Lime and silica combine to form two compounds: (1) The metasilicate—which exists in two stable crystal forms: (*a*) Wollastonite, stable at ordinary temperatures and up to 1,190° C.; (*b*) pseudo-wollastonite, stable from 1,190° to its melting point, 1,512°. (2) The orthosilicate—with three stable crystal forms which were designated for convenience: α, stable from 1,410° to the melting temperature, 2,080°; β, stable from 675° to 1,410°; γ, stable at ordinary temperatures and up to 675°.

The metasilicate of lime combines with the metasilicate of magnesia—possessing two stable and three unstable crystal forms, of which one (unstable) corresponds to enstatite—to form only one mineral, diopside, stable at all temperatures up to its melting point, 1,395°.

The measurements were made at constant (atmospheric) pressure and in the absence of water.

The measurements themselves depend upon: (1) the chemical purity of the component minerals; (2) the ability to establish equilibrium between them at the temperatures where the characteristic changes occur within the time available for a laboratory experiment; (3) sufficiently sensitive and accurate temperature measuring devices to locate with certainty every characteristic change in the energy content of the system.

The Slumgullion Mud Flow: Mr. WHITMAN CROSS.

The Slumgullion mud flow is a landslide of unusual character, which took place many years ago in an eastern tributary of the Lake Fork of Gunnison River a few miles above Lake City, Colo. The damming of the Lake Fork by this flow caused Lake San Cristobal, a sheet of water two miles long.

The flow originated at the south end of a high ridge at the head of a minor branch of the Slumgullion drainage. From this point, with an elevation of about 11,500 feet, the flow descended 2,500 feet to the valley of the Lake Fork, four miles distant from the source. The material of the flow now fills the valleys in which it lies to a probable elevation of 150 to 300 feet above the original bottom.

The topographic features of the flow are very pronounced. It is bounded for nearly its entire length by two moraine-like lateral ridges of very sharp outline. Between these the flow is usually lower and characterized by furrows and trenches, knolls and hollows of confused relations resembling those of modified landslide areas or of some glacial deposits.

The material of the flow is mainly a soft, light yellow or nearly white decomposition product of pyroxene andesitic lava and irregular fragments of the same rocks, some of which are fresh, while more are partly altered. The origin of the flow is intimately connected with this decomposed condition of the andesite at its head. It appears that at the end of the ridge mentioned a large mass of andesite belonging to a complex of flows was extensively decomposed, the product consisting principally of opaline silica, hydroxides of iron and alumina and gypsum, forming a soft mealy mass which on saturation with water became a liquid mud. On this mass rested less altered beds of andesite.

It is believed that at a certain time unusual softening of the mass by water caused it to give way, and that the greater part of the visible flow descended at one time, in the manner illustrated by mixtures of soil and rock waste which, on a much smaller scale, frequently flow down ravines or mountain slopes as a result of cloudbursts.

The Slumgullion flow took place before the beginning of the present heavy forest growth and after the glaciation which produced the morainal deposits on the adjacent slopes.

FRANCOIS E. MATTHES,
Secretary

THE ACADEMY OF SCIENCE OF ST. LOUIS

THE academy met at the academy building, 3817 Olive St., Monday evening, May 17, 1909.

Professor W. E. McCourt, of the department of geology of Washington University, presented an illustrated paper on "Diamonds in Arkansas."

Professor McCourt first gave a general account of the properties of the diamond, and an account of some of the famous diamonds of history. Then the general commercial occurrences of the diamond were considered—namely, India, Brazil and Africa, whence the world's supply of diamonds has largely come. Diamonds have also occurred in the United States, some of them to a size of fifteen carats, but nowhere in very large quantities.

In 1906, however, diamonds were found derived from a parent rock in Pike County, Arkansas, near the town of Murfreesboro. The presence of the rock in this region, similar to rock in which diamonds were found in Africa, has been known for some time, and the state survey has mapped one of the areas. The igneous rock is a peridotite which has been pushed up through the Carboniferous and Cretaceous quartzites and sandstones, and in places is covered by beds of Post-Tertiary and Quaternary formations. But there does not seem to have been any metamorphism accompanying the intrusion of this material. This peridotite is dark colored, basic igneous rock which contains olivine, augite, magnetite, mica and perofskite. In some places the rock is exceedingly hard and dense, but in others it has weathered to a yellowish and greenish soft material to a depth of from twenty to twenty-five feet. Covering the region to a depth of a foot or so is a black gumbo soil which contains fragments of the hard peridotite and the country rock.

The work in this region has not been very extensive, but bore holes have been made in several places, one reaching to a depth of 205 feet in the hard rock; several companies have located on the area; and stones to the number of about 600 have already been found. The largest stone is six and a half carats. Some have been cut and are valued at $104 a carat. The colors vary, most of them being white, brown and yellow, though one blue diamond has been found and several black ones.

From these indications this area seems to contain a mass of rock similar to the rock in South Africa. But as to the number of diamonds which may be found deeper in the peridotite, that, said Professor McCourt, is a question which can only be settled by actual mining and testing. The results which have been shown by the more or less spasmodic exploitation, however, seem to indicate a good promise.

Professor Nipher stated that he had been unable to finish his work on electrical discharges on account of recent developments. He has found that the electric corpuscles can be focused by means of a fiber of red glass lying on the film of the photographic plate. When the positive and negative terminals of the influence machine are grounded at different points, he finds evidence that the corpuscles are discharging from the negative line to surrounding bodies. They are also moving from surrounding bodies to the positive line. This refracting device seems to furnish a way of making further studies on electric fields.

The following memorial was adopted in memory of Dr. H. Aug. Hunicke, corresponding secretary of the academy at the time of his death:

Dr. Henry August Hunicke, at the time of his death on April 5, 1909, had been a member of the Academy of Science of St. Louis for rather more than twelve years, during five of which he held the office of corresponding secretary.

His active interest in everything appertaining to the labors of the academy is indicated, not only by his contributions to its scientific proceedings, but also, to an even greater degree, by his active participation in the business of the council, in matters of organization, in the discussion of questions of policy and in the promotion of measures designed to broaden the scope or to increase the usefulness of the academy.

He was an effective speaker, because his outlook and his sympathies were both broad and deep. Although a keen debater, he was uniformly considerate of the feelings of others and never permitted himself to treat his opponent of the moment with anything less than the most perfect courtesy. His spirit was ever helpful, encour-

aging, warmly appreciative of merit or good intent, but he was, nevertheless, quick to detect and to comment upon faults in logic or on errors of any sort. Such criticisms were always without rancor and were delivered with a touch of humor and with so delicate a tact, that, while they enlivened debate, they rarely or never gave offense.

As a councillor, his advice was highly valued, because he looked to the end, being not easily diverted from the main objective nor disposed to waste time over side-issues or trifles, and because he neither underestimated the adverse view nor overstated his own.

In his various capacities, as adjunct professor at Washington University, as a resourceful and able technologist, and as a close student of certain strictly scientific applications of the theory of thermodynamics, Dr. Hunicke enjoyed in full measure the respect of those who were in a position to judge his work, and so achieved his reputation; but in the minds of his colleagues of the university and of the academy, his truest claim to distinction lies in the exceptional qualities of heart and character, which endeared him to his friends, which were a constant inspiration to all who came within the sphere of his influence and of which the memory constitutes a living monument in his honor.

The Academy of Science of St. Louis places this record in its archives as a brief token of respect and as an expression of its sense of the severe loss which the academy and the world have sustained in his death.

Launcelot W. Andrews,
Chas. D. Stevens,
H. A. Wheeler

The academy met at the academy building, 3817 Olive St., Monday, June 7, 1909.

Professor W. E. McCourt, of Washington University, exhibited a number of photographs taken in Onondago Cave, near Leesburg, Mo., and described the formations found there.

Professor F. E. Nipher, of Washington University, gave a verbal account of some of his recent work on electric discharge, stating that his paper on the subject has not yet been completed.

He has recently obtained what have the appearance of shadow images of glass fibers laid across the film of a photographic plate enclosed in a hard-rubber holder, although the fibers were not present. They had been laid across the film of another plate previously exposed in the same holder. When the fibers were present they gave black focal lines on the negative. The after images formed on the next plate were white shadow images. The electrons which came from a highly charged line wire from the negative terminal of a plate glass machine were on the second plate deflected away from the lines upon which they had been converged in the first plate. This indicates that the effect is due to electrons and not to ether waves or ultra-violet light.

Experiments of the same kind with X-rays have given negative results. Previous exposures of plate holders to electrical radiations do not appear to affect X-ray images, although this matter is still under examination.

Later experiments to determine momentum effects around an angle in a wire have been made by placing the angle flat upon a sheet of glass. It is held in place by means of a fine silk thread doubled around the wire at the angle and attached to a helical spring. A photographic plate may be slipped under the wire at the angle. A sheet of black paper is inserted between the film and the wire, and a larger sheet is laid down upon the glass plate. These sheets of paper cut off luminous effects due to the discharge. If these sheets of paper are used a second time during the day, images of the wire due to previous exposures are formed on the plate. The momentum effects previously observed and reported are less marked by this method, and can only be obtained by placing a grounded and laminated condenser plate below the sheet of glass upon which the plate is supported. This deflects the negative particles downward upon the film.

It has also been found that the smooth aluminum wire lying flat upon the sheet of black paper in contact with the film, produces under some conditions an image which shows a sharp system of wave forms. The breadth of the image is about 3 or 4 mm. at the widest part and inappreciably small at the nodal points. The wave-length and position seem to be affected by the angle in the wire and the local geometry of the circuit around the angle. The wave-length is about 2×3.75 cm. The wave forms reverse their positions in a symmetrical way when the direction of the discharge is reversed. It is suspected that the tension on the wire has something to do with these wave forms. When the tension is small they are not observed. There is, however, much remaining to be done in the study of these phenomena.

W. E. McCourt,
Recording Secretary

SCIENCE

FRIDAY, JULY 30, 1909

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE MEDICAL SCHOOL AS PART OF THE UNIVERSITY[1]

IN our educational systems, as in most of the complex institutions of human origin, the changes that are constantly occurring do not seem to follow a course of continuous symmetrical development. The manner of growth appears to resemble rather that process of exuviation with which we have been made familiar in the life history of the humble crab and his crustacean relatives. That is to say, at certain more or less regular periods our systems become enveloped in a case of customs and traditions of shelly consistency, which, while it serves as a protection toward dangers from without, afflicts greviously by and by the growing parts within. In the end the increasing pressure becomes distressing or painful and the only way out of the predicament is to moult the old shell and grow as fast as possible before a new one takes its place. The system of education in medicine has in fact been undergoing a moult for some years past and what I have in mind to-day is to call attention to the fact, perhaps already sufficiently obvious, that the process is not entirely completed. While certain parts of the system are free from the old constricting influences and are at liberty to grow and expand in proportion to the measure of vitality with which they are endowed, other parts are still encased in ancient shell which serves as an obstacle to their proper development.

During the last twenty years especially medical education and the condition of medicine in general in this country have been the subjects of much earnest discussion. Critics within and without the pro-

[1] Annual address in Medicine, Yale University.

fession have exposed its weaknesses in the merciless way appropriate to their rôle, and reformers have cried aloud its deficiencies from the house-tops. One naturally inquires what is the cause of all this stir? What has happened to create such dissatisfaction with a system that formerly was accepted without comment? The ills and accidents which afflict mankind are not greater or more numerous than in former times. The pestilence still walks in darkness and destruction wastes at noonday as of old, but not more so. Indeed we flatter ourselves that we are better off than our ancestors in these regards. But we take a different attitude toward them. Our forefathers did what they could to escape these ills and in biblical phrase sought to their physicians with more or less satisfactory results. But what they could not avoid or prevent they accepted submissively as an act of God, a phrase which some one has defined in comprehensive manner as including all those acts which no reasonable man can foresee. In these latter days, on the contrary, there is a wide-spread feeling that man should be able to apply his intelligence so as to reach a more satisfactory understanding and control of disease and pestilence. The reason for this change of attitude toward nature is to be found, without doubt, in the great increase in our scientific knowledge. Physics, chemistry and biology have added immensely to our comprehension of the processes of nature, living as well as dead, and this acquisition has awakened in us a keen desire to apply all this knowledge practically in saving ourselves as far as may be from sickness and death. If we can find out the secrets of the stars and bend the forces of nature to our use and pleasure, can we not also unravel to some extent those mysteries of life and death which after all are the phenomena of paramount importance to us in this universe in which we find ourselves placed. This same desire to apply scientific knowledge to practical medicine was apparent in Europe early in the nineteenth century. Investigations of the laws controlling inanimate nature had spread rapidly to a similar study of the properties of living matter, although the transition was attended by some convulsive qualms among the timid and superstitious. Foolish and ineffectual attempts were made to discourage the bold pioneers by charges of impiety or by predictions of the necessary futility of all efforts to solve such great mysteries. In medicine, especially, this kind of opposition was very common, and the enlightened members of the profession contended against many unnecessary difficulties in their efforts to introduce the methods and results of science into the practise of medicine. Our own country was very slow in feeling the effect of this movement. We are all aware that medical education and therefore medical practise in this country, speaking in general terms, were until recent years far below the standard maintained in Europe. Conditions among us, in fact, were such that for a time things went from bad to worse. Our curve of efficiency kept falling, while in other civilized lands it rose more or less parallel with the growth in scientific knowledge. There thus came to us a certain distinct and admitted inferiority in medical matters which has not yet been fully overcome. Many excuses and reasons might be offered for the backwardness of our development in medicine, but the excuse most frequently made was and is that our growing country has need in the outlying districts for an inferior type of physician willing to work hard for little pay, and consequently entitled to receive his degree in medicine at little expense of time or money. A need of this kind undoubtedly existed, but it scarcely justified

the creation of the numerous poor schools with which this country was afflicted, and whose ill-prepared graduates practised in the centers of population as well as in the outposts of civilization. One can not entirely suppress the suspicion that motives of personal gain and commercial expediency were largely responsible for the deplorable condition that prevailed in the latter half of the nineteenth century. A few schools possessed of good traditions made an earnest fight for better things under very adverse circumstances, and we must recognize that among the graduates of the poorer schools there were some who became able and even famous practitioners. I venture to believe that this latter result was in no way due to the system, but is to be explained by the fact that the profession of medicine will always draw to itself a considerable number of able and high-minded men, who are bound to make themselves felt upon whatever system their education may be conducted. But the general output of medical graduates was for a time far inferior in quality to that supplied to other nations. What else could be expected from a system which permitted, indeed actively encouraged, men to enter the medical school without any previous education and then qualified them to practise upon the public after a bare ten or twelve months' study of the science and art of medicine? It was much easier at one time to enter the profession of medicine than to become a recognized journeyman in a trade. The conditions indeed became bad enough to call urgently for reform, and this call has grown increasingly imperative down to the present day. In a democratic country like ours a reform in a system of education is naturally a slow process. Under a more centralized form of government it is only necessary to convince the few who have authority and the desired reform may be inaugurated promptly and effectively. But with us it is requisite to arouse the people at large. If an improvement is called for it can only be established permanently by creating an enlightened public opinion in its favor. It happens therefore in medicine as in politics that the country gets about the kind of service that the majority thinks it wants, and progressive leaders have a very hard time in making that majority change its ideas. Certainly in medicine the effort for reform has been a long and laborious one, but we may feel sure that now the tide of public opinion has turned in favor of a better system. A necessary preliminary step was the development of an appreciation of science in this country. Fortunately our colleges and universities have made splendid progress in this respect. They have created a scientific atmosphere, they have let loose among us a scientific spirit which has entered like a ferment into the medical schools. There, like a ferment, it has caused much commotion and unrest of a healthy and normal kind, the end-result of which will be no doubt the establishment of a system of medical training as good at least as that found in other countries of the same grade of civilization. It may be interesting to inquire how far we have advanced toward this desirable end; and in what direction our present tendencies are taking us. The positive results of the agitation begun during the present generation are important and satisfactory. Our schools, if we take them all into account, are still so heterogeneous that it is scarcely possible to make any general statements that shall be equally applicable to all, but we have an increasing number of strong schools which are setting the pace for the rest, and those that can not keep up will have to drop out of the race altogether. According to reports thirty schools surrendered to this fate

during the past five years. The better schools, which we need alone consider in this matter of the status of our development, are organized, almost without exception, as the medical department of a university. Herein lies the secret of their success and the promise of their improvement in the future. In these schools there is firmly established a four years' graded course, of which the first two years are devoted largely to the preparatory medical sciences of anatomy, physiology and pathology, using these terms in their broad sense to include such subjects as histology, physiological chemistry, pharmacology, etc. The most significant fact, however, is that these preparatory sciences are taught by specialists who give their entire time to the work, and whose methods and ideals differ in no essential respect from those followed by teachers of physics, chemistry and biology. In other words, the instruction in these medical sciences has been raised to the university level, as has been the case now for so many years in the German schools. The change in the character of the instruction in these subjects has brought it about that in many of our colleges and universities they are accepted as appropriate courses for academic degrees, a recognition which I believe will soon become general. For when properly taught a course in anatomy, physiology or pathology gives a liberal education and a mental training which are of value to any man, whatever may be his career in after-life. These subjects deal with the great problems of existence, the riddles of life and death and propagation, and all the properties of that extraordinary substance which we call living matter; they throw light not only on the special questions that interest the physician, but they furnish also valuable material for the practical use of the sociologist, the political scientist, the philanthropist and the statesman. Moreover, they bring us close to the highest and most difficult subject that the human mind is called upon to contemplate, that is to say, the relationship between ourselves and the material universe, the ever-fascinating and mysterious interdependence of mind and matter. Much has been said upon the subject of the cultural value of liberal studies as opposed to so-called professional or technical studies, but in all discussions of this kind there is a tendency toward a certain arbitrary assumption that courses of studies must fall wholly under one or the other of these rubrics, whereas common experience teaches us that merely putting a label upon a thing is no guaranty that the contents are thereby properly described. The preparatory training for life should be liberal and humanizing, but it is quite possible that many different lines of study may lend themselves with equal success to the development of these qualities, and it will be admitted perhaps by every one that the courses of study in college, in addition to having a broadening influence upon the student, should also inculcate in him some specific kind of mental training which will fit him better to take a high rank in whatever career he may happen to select.

The term technical, as applied to courses of instruction, has acquired an unfortunate connotation which implies that they are lacking in value from the standpoint of general training. As a matter of fact, many of the graduate courses given in our universities are quite as technical as those given in the preparatory sciences in the medical school, and for one as for the other it is short-sighted to assume that they are devoid of a general educational value. I prefer much the definition of the term technical which has been given by Professor Karl Pearson. He makes a distinction between technical and professional instruc-

tion, or, to use his precise terms, between technical education and professional instruction. Under the latter term he includes training in the art of a specific profession—that kind of training which the apprentice gets from his master in the specialized methods and handicraft peculiar to the vocation—the kind of training which, in the case of the physician, is obtained in the wards and clinics in contact with patients. By technical education, on the other hand, he means that training in the underlying subjects of a profession which makes for the development and strengthening of the mental faculties. The technical education of the physician in this sense lies in the physical and natural sciences, including under the latter term the whole range of the biological sciences. Whether any given course in this category meets Pearson's definition of technical education is determined by asking whether it "provides mental training for the man who has no intention of professional pursuits." Judged by this standard, we may understand that it is the method in which a science is taught as much as its contents which determines whether or not it has value as an intellectual preparation for life. I have no doubt that various subjects, scientific or otherwise, are taught at times within the walls of the universities in such a way that they miss the larger end and confer only the restricted benefit of a special knowledge which is truly professional for that subject. There can be, however, no hesitation in claiming that the subjects of anatomy, physiology and pathology as they are taught or should be taught in our best medical schools are adapted to give a training to the mind as broadening and as generally beneficial as courses in physics, chemistry, biology or indeed as any of our university courses which deal with special departments of human knowledge. So far as graduate instruction is concerned this contention has long been admitted in this country, and the subjects we are considering are listed upon the programs of study in both the philosophical and the medical faculties. In later years many colleges have gone a step farther and have accepted these courses as part of a general scientific training for those students who are looking forward to a career in medicine. It is perhaps only a matter of a little time before they will be admitted to the same standing in all respects as the other sciences, that is to say they will be considered not only as subjects of special medical interest, but as conveying knowledge of the widest human interest and importance. So far as the subjects themselves are concerned they enjoy their widest opportunity and best environment when the medical school forms an integral part of the university, not only in organization, but in location as well. If it so happens that geographically the medical school is separated from the rest of the university it is not a matter of vital importance, so far as I can see, in which set of buildings these subjects are taught, provided only the teachers are of the right sort. This opinion, I am glad to say, is merely by way of confirmation of the practise that is actually coming to be established among us. When these subjects are segregated with the clinical branches something, no doubt, of the university atmosphere is lacking; when they are separated from the clinical side there is a corresponding loss of medical atmosphere. Which is the more serious loss, or whether there is any material difference in the final result, it is difficult to say. The medical student probably values more highly the medical surroundings. They give significance to the things that he is learning and in various informal ways they furnish him with op-

portunities to acquire the points of view and the methods of practical medicine. On the other hand, they have the disadvantage of distracting and diverting some students from a thorough study of the preparatory sciences. I have had frequent occasion to observe this effect. Some of our medical students chafe under this prolonged preparation, forgetting the fact that it is an opportunity which may never come to them again, and forgetting also that it gives them the badge, the impress that will differentiate them from the mere empiric, when the time comes for them to compete with their fellow practitioners. To the teachers, on the contrary, particularly if they belong to the productive type, the university atmosphere is perhaps more stimulating. The methods and ideals of these teachers are more closely related to those of the university professors than to those of their clinical colleagues. For while research is valued as much perhaps in the medical department as in the philosophical department, there is the difference that in medical circles the reward of immediate appreciation goes chiefly to those investigations that promise to have a direct practical application. The medical atmosphere encourages research by the sharp stimulus of an abundant reward for practical results. The university spirit or the academic spirit, on the other hand, takes the wider and wiser view that looks beyond the immediately useful to the large results that may be expected from a growth of knowledge in general. This serener atmosphere forms a grateful environment for research, and in the long run no doubt it produces the larger harvest of useful knowledge. Investigation after all is always a voluntary offering. There is no way of compelling it or of estimating its value in terms of time or quantity, and men who investigate do not like to be put under the pressure of demonstrating that the work they do is of immediate importance to mankind. They prefer to study those problems which for one reason or another have aroused their interest. Considering the complexity of nature, especially the living side of nature, and remembering how difficult, even dangerous, it is to apply knowledge that is incomplete, the rest of mankind would do well to encourage in every way the little band of investigators whose chief ambition and pleasure in life is simply to add to our store of knowledge. As a matter of fact mankind generally does not place a very high estimate on the work of these disinterested individuals whose labors contribute to the common good rather than to personal gain, although history teaches us in an infinite number of ways that on the work of such men depends in large measure the possibility of progress. Perhaps the explanation lies in the fact that the good these men do comes after them, it benefits posterity rather than the present generation, and we are inclined to let posterity do the appreciating as well as the benefiting. But this is a line of thought aside from our present purpose. The conclusion that I wish to emphasize is simply that all the agitation that has been going on in medical circles during the past two decades has resulted finally in the establishment of two reforms in medical education. First, the preliminary training for entrance upon the medical career has been greatly increased. Starting with practically nothing at all, it was raised first to a common-school education, then to a high-school education and finally, in the university schools, to a college preparation, partial or complete. Second, in the medical course itself the work of the first two years has been so arranged that it continues the traditions and methods of the university in the study of the so-called underlying

medical sciences. It will be observed that these two important results have to do with the preparation for practical medical work. On the old system two years were given to acquiring a sufficient knowledge of the art of medicine. As scientific knowledge increased and penetrated into medicine the period of instruction was prolonged to four years, or taking into account all of the necessary preparation, to six or eight years, but all of this additional time was devoted substantially to preliminary or preparatory training. This is a significant fact. All of the truly art side of medicine or of any other profession may be acquired on the apprenticeship system, without any previous preparation other than is implied in a basis of general intelligence. It is the scientific side of medicine which calls for all of this extensive preliminary training. Without it one might still in a two years' course make a capable practitioner, to use a distinction made long ago by Magendie, but not a scientific physician. The difference between an able practitioner and a scientifically trained physician is not so striking that it can be appreciated at once by the public at large. The difference is there, however, and eventually it means everything to the advancement of medicine to recognize this difference and to increase it by every means at our command, whatever cost of time and money it may entail. Excellence is generally the thing that costs. If by the expenditure of more money we can add a knot or two to the speed of our steamships we know that it pays us to do so, and if by longer and more expensive training the efficiency of the physician may be increased a little, the difference is worth the cost, for it also will add much to the happiness and prosperity of the whole community.

The content of the curriculum of our first two years, and the character of the instruction given during that period, may be modified more or less from time to time. It may be expanded or more probably it may be simplified, but it seems to me that our system of medical instruction in this country is committed definitively to the general principle that these medical sciences shall be taught as the other sciences in the university are taught, by specialists who give their entire time to the work and who are active in research as well as in instruction. The force of successful example will compel all schools to follow this type. But, we may ask, is there no change that is desirable in the system of instruction in the clinical branches? This is a question which ought to be discussed by clinicians as by those who know whereof they speak. But it is a general truth, perhaps, that reforms in teaching do not usually originate from those occupying the positions in which changes are called for. Feelings of personal interest or loyalty to traditions prevent them from seeing clearly the defects that may be obvious to others. It comes about, therefore, that the initial impulse to reform is often forced upon us by criticism from without. In regard to the teaching of the clinical subjects in our medical schools three general changes have been suggested at one time or another and are likely to come up for serious consideration in the immediate future. First, shall the time devoted to these subjects, under the auspices of the medical school, be lengthened? At present the usual plan is to give two years to this side, and the definite suggestion made is that a third, exclusively hospital year, shall be added. I shall not stop to discuss this question. Our graduates themselves realize the value of this additional experience and in increasing numbers every year they are seeking a term of service in the hospitals before entering upon private practise. It seems to

me most probable that we shall find it advantageous to follow in this respect the example set for us by the older countries, that is to add a year of hospital service as an obligatory part of the requirements for the degree in medicine or for the license to practise medicine. As we all know, this change has been strongly recommended by the council on education of the American Medical Association. Second, there is much complaint from many sources, particularly from the teachers of the medical sciences, that the professors of the clinical subjects do not make adequate use of the results and methods of science in their instruction. What is the use of giving the student a scientific training if the man who instructs him in diagnosis and treatment neglects to show wherein this knowledge is applicable? This is largely a matter of comparison. We know that in foreign countries the clinical teacher is usually well prepared to use the results of science. In our own country, outside some anatomy, normal and pathological, this statement can not be made. Our best clinicians heretofore have been lacking in acquaintance with the facts and methods of the underlying experimental sciences. This, however, is a defect which time no doubt will remedy. The newer appointments to these chairs will be made from a group of men who have enjoyed the benefits of a better scientific preparation. It would, however, be a real advance if we should adopt what seems to be a practise in other countries, namely, to require those who expect to take positions upon the medical or surgical staffs to serve a preliminary year or two in a scientific laboratory, engaged upon research not too immediately practical in character. The suggestion made by Dr. Bevan that the positions upon the clinical staff might be filled by men who had served as instructors in anatomy, physiology or pathology is most excellent. If this procedure became customary, if the professor of medicine, for example, selected his assistants from the teaching staff of the departments of physiology, physiological chemistry and pathology we should have an arrangement which, on the one hand, would supply the clinical departments with well-trained men, capable of undertaking independent investigations, and, on the other hand, would probably direct toward the laboratory subjects an abundant supply of young medical graduates, whereas under present conditions it is frequently necessary to go outside medicine in filling such positions. Third, What shall be the character of the duties and qualifications expected from those who have the chief direction of the work in the clinical departments? It is an interesting and somewhat surprising fact that in this part of our system of medical education no change of importance has been made in the methods of teaching during the last few decades. So far as the student himself is concerned no fundamental change in opportunities is required. Clinical instruction from the students' standpoint always had the great merit that it employs what we may call the laboratory method, as opposed to the method of learning from books. The student is brought face to face with experiments made by nature and he is given an opportunity to learn from personal experience rather than from the experience of others. In our modern schools his opportunities of this kind have been greatly increased and to this extent his instruction has been improved in his clinical years along the same line as in his preparatory years. But has there been a development in the methods of teaching in these clinical years corresponding to that which has taken place in the laboratory subjects? What we find is that the backbone of the instruction in the clin-

ical branches consists now, as formerly, of exercises in the clinics and operating rooms of the hospital and the dispensary, and these exercises are conducted by practitioners of medicine who devote a little time to their duties as teachers, but give most of their time and energy to their private interests. As long as our medical schools were private corporations founded partly for the public good, but partly also for the personal advancement of the members of the corporation, this division of time was natural and permissible. But our best schools are no longer private enterprises; they constitute a part of a university whose functions are solely to advance the public good and not in any sense to exploit private interests. As has been well said by one who speaks with great authority, the university discharges its direct duties to the public in two general ways, by teaching and by investigating; by providing systematic instruction in all forms of that knowledge which has been accumulating from the beginning of our race, and by promoting all good methods for increasing knowledge. These duties are performed through her teachers. She therefore selects her professors for their ability to teach and to investigate, and to insure that these functions are performed in the best possible way they are required to devote themselves entirely to her service. In this respect, as we know, the professors in the clinical branches, and possibly also the professors in some of the other professional schools, are on a different plane from the university professor proper. It is an interesting, and it seems to me a perfectly proper question to ask whether this distinction is a necessary and advantageous one. Does it constitute an inherent characteristic of professional instruction? This is a somewhat delicate and complex question which should be discussed not simply from the standpoint of the ideal, but also with reference to what is really feasible under conditions as they exist. Time does not permit such a discussion and I must limit myself to a brief statement of what seem to me to be the tendencies now developing. One curious, if not important, phase I may note in passing, namely the practise that seems to be growing of paying the clinical professor the full salary given to the other professors in the university. The professor in the clinical subjects is designated as a professor in the university, and although he is permitted to engage in a lucrative private business he is given a salary as large as that paid to the usual professor who devotes his entire time to his university duties. There is a manifest inequity in this practise, and it produces a distinct feeling of discontent among the teachers. It would seem to me that the university ought not to submit to this condition, unless it is actually forced to do so to obtain the men that it wants. As a matter of fact the indirect benefits attached to these positions in a good university school are so great that I believe there would never be difficulty in obtaining the best men to fill them whether they carried a salary or not. But if a salary is attached it should certainly not be so large, under present conditions, as that paid to other university professors, otherwise the university deliberately places a premium on the teaching done by the clinical instructors which tends to discredit the work of the other teachers. But this is a more or less incidental matter. The really important standpoint from which to view the subject is what are the means by which the university, through its medical department, can discharge most efficiently its obligations to the community. It wants to send out practitioners of medicine qualified in the best possible way to treat the sick, it

wants to do its part in throwing additional light upon the causes and treatment of disease. Now the first of these functions is not so very difficult of performance. Under conditions as they are teachers of medicine and surgery can be obtained who will give to students the best methods of diagnosis and treatment, and so far as the limited time permits will send them out into the world prepared to develop into competent practitioners of medicine. There can be no doubt, however, that this function would be performed more satisfactorily from the standpoint of the school if an arrangement could be made whereby the professors gave more time to the work of instruction. But the provisions made for the advancement of knowledge by investigation are not so satisfactory as they should be. Whatever may be the position of a proprietary school in this particular, the university school surely can not be satisfied with playing the part of a mere reflector of knowledge. The spirit of investigation is wide-spread in medicine at the present day. We have the highest kinds of hope that the methods of science may be applied with success to the study of diseases of all kind. There has been an extraordinary increase in our knowledge of infectious diseases, and resulting therefrom a really wonderful improvement in our control of the conditions threatening public and private health. All this we owe directly to the use of the laboratory method of investigation. A similar victory may be gained over the numerous constitutional and nutritional diseases whose causes are at present hidden in the secrets of the body metabolism, but to accomplish this desirable end, or at least to accelerate its accomplishment, we must organize more satisfactorily our means of investigation. Shall we limit our investigations to the laboratories of the medical sciences and to special institutes, or shall we extend them into the clinical branches? It is almost useless to put such a question. Investigation by experimental methods has spread into the clinical departments, and a great increase in the development of this phase of research activity may be regarded as inevitable. The point that has been raised and which I should like to emphasize is that our present system is not well adapted to promote this kind of work. Our custom is to appoint as heads of these departments men who are engaged in the practise of medicine, and it is perfectly evident that if these men give themselves unreservedly to the demands of practise their efficiency as teachers and investigators will be seriously impaired, indeed, in the latter particular, will probably be destroyed altogether. To attain the combination of those qualities which are most desirable from the view-point of the university one of two changes should be made. Either there should be a definite limitation placed on the time given to outside practise, so that opportunity of a known extent may remain for teaching and research, or these positions should be placed squarely on a university basis, the practise of the incumbents being limited to the hospital and dispensary and the laboratories attached to them. The two propositions bear to each other somewhat the relation of a half loaf to a whole loaf. Neither of these principles is in force today, so far as I know, in any of our better schools. Investigations that bear directly on the problems of practical medicine are carried on in the laboratories of the medical sciences, in the special institutes, and by the younger men in the clinical departments who are preparing themselves for higher positions. We possess also a certain small number of professors of medicine and surgery who, in spite of abundant opportunities offered to enlarge their incomes,

are so deeply interested in the work of investigation that they voluntarily limit their outside practise and devote a considerable portion of their time and energy to genuine research. These are noble spirits, for they make a real sacrifice for the sake of a worthy principle. Medicine owes much to them not only for results actually obtained, but also for their example and influence which permeate the whole department with which they are connected, and influence favorably to some extent every student brought into contact with them. But the number of such men is very small, for I would not add to this honor list those whose names appear sometimes in our literature as contributors, but who are in reality patrons of research rather than actual workers. The position of our clinical professors in relation to their duties toward the school, on the one hand, and their opportunities for increasing their private practise, on the other, is so similar to that which formerly existed in the departments of the medical sciences that one naturally assumes a similar outcome. The practitioner was displaced from the chairs of anatomy, physiology and pathology, because the scientific knowledge and laboratory technique had become so specialized that it was impossible for the man in practise to do the professorial work with honor and success. The principle of competition between the schools soon determined which kind of professor was most needed. In the same way precisely science and laboratory technique and the spirit of investigation are pushing hard into the clinical branches. The professor of medicine who gives himself to outside practise, and at the same time attempts to keep up with the scientific development of his subject and to make and direct the investigations which his position in a good school demands is putting himself under a great strain at present, and the indications are that soon this strain will become too great. Specialists will be demanded for the heads of our practical branches as they are now for our theoretical branches. It seems quite possible that here again the principle of competition will be the decisive factor. The university school which shall first establish departments on this basis may, and in my opinion will, secure both reputation and students as compared with schools organized on the present system. Whether a professor of medicine, surgery, obstetrics, etc., whose practise upon patients is limited to the hospital and dispensary will be as well qualified as the man with an extensive outside practise to teach his students medical art as well as medical science, and to attain the proper influence among his brother physicians are questions that have been somewhat discussed, but the only way to find out the correct answers is to try the experiment. All the theoretical reasons favor such a change. The practise of the hospital is much more rigorous than private practise from the standpoint of the acquisition of the methods of diagnosis and treatment. I fancy that any physician will admit that experience and real knowledge accumulate at a rapid rate in the hospital as compared with the results of the looser discipline of outside practise. A man whose diagnoses are based upon the most complete examinations possible and whose errors are continually subject to the salutary correctives of autopsy and pathological demonstration is likely to make a very exact and practical teacher. As regards the matter of the relation of these men to the medical public there can be no room for a difference of opinion. It is they who would have the golden opportunity to acquire precise knowledge, to keep thoroughly abreast of the latest and best in the medical world: It is they who in medical societies and

medical journals would be best qualified to speak with full knowledge, and in professional circles knowledge gives authority whatever may be the case with the public at large. A practical difficulty in making such a change in the character of the appointments to the clinical chairs, which interests the university authorities directly, is the doubt whether properly prepared men would be willing to surrender the rewards and popular appreciation that are attached to the career of a successful physician. This is again the kind of question that discussion does not throw much light upon. When we meet with difficulties of this kind in laboratory work we put the matter to the test of experiment and thereby settle the dispute. Our country is in a peculiarly favorable position to make such an experiment. Our system of medical education has heretofore simply developed along lines laid down by the experience of foreign countries; perhaps in the direction suggested above we may have an opportunity to take the lead instead of trailing along in the rear. I have had occasions to talk with a number of young clinicians on this topic and I have arrived at the conviction that many of them would eagerly accept an offer which, while assuring them a modest but sufficient competence, would also open to them a career so promising in influence, reputation and possibilities for doing the highest good to mankind.

W. H. HOWELL

THE JOHNS HOPKINS UNIVERSITY

THE WINNIPEG MEETING OF THE BRITISH ASSOCIATION[1]

ON Wednesday, August 25, the British Association for the Advancement of Science will meet for the third time in the Dominion of Canada. Twenty-five years ago the first Canadian meeting of the association was held in Montreal. Thirteen years later, in 1897, advancing a stage further westwards, the association met in Toronto. This year the place of meeting will be Winnipeg, the Gateway City, as it has been called, of the Canadian northwest.

The growing frequency of these flights of the British Association to the dominions beyond the seas will be realized when it is remembered that in the interval since the meeting in Toronto the association has paid a visit (in 1905) to British South Africa. The Montreal meeting in 1884, which initiated the extension of the British Association's meeting-grounds to places outside the British Isles, was not decided on without many heartburnings. For over half a century, since its establishment in 1831, the association had always held its annual meeting in one of the ancient seats of learning or one of the centers of modern industry and commerce in the mother country; and the proposal that it should depart from this custom excited much opposition from those who were wedded to the old order of things. The proposal was first mooted at the jubilee meeting of the association at York in 1881, when Captain Bedford Pim gave notice of his intention to move at the meeting of the following year "that the British Association do meet in Canada in 1885." In Canada itself this proposal was taken up with the greatest heartiness; and before the end of the year the Marquis of Lorne, then Governor-General of Canada, wrote to Mr. William Spottiswoode, as president of the Royal Society, giving an invitation to the association to meet in the dominion in 1883. Various circumstances prevented the council of the association from accepting this invitation, whereupon a further invitation was sent to the association to meet at Montreal in 1884. With a view to testing the feeling of members of the general committee with regard to a proposal which undoubtedly involved a serious departure from the accepted policy of the association, a circular letter was issued inquiring how many members of the committee would be able to accept the Canadian invitation. Only 230 out of 700 members of the general committee re-

[1] The London *Times*.

plied to this letter, and of these replies only 74 were favorable.

At the Southampton meeting in 1882, the proposal was discussed at length, and ultimately it was decided to accept the invitation from Montreal. So strong, however, was the feeling on the part of many members against what they regarded as an undesirable and dangerous innovation that a memorial was drawn up and presented to the council, questioning the legality of the decision to meet outside the British Isles and calling for a special meeting of the general committee to be summoned to reconsider the matter. This request was not acted upon; and at the Southport meeting in 1883 the council was able to show that all fears that the proposed Canadian meeting would prove a fiasco, owing to the failure of any considerable body of members to attend, were groundless, since between four and five hundred members had already signified their intention of taking part in the Montreal meeting. As a matter of fact, as the time for meeting drew near so much eagerness was shown to take part in the visit of the association to Canada that the council had to take steps to restrict the election of new members. Many persons who failed to secure election in England went out to Canada without vouchers and presented themselves for enrolment in Montreal; and altogether the total number of visitors who crossed the Atlantic and registered their names on the lists of the association in Montreal amounted to 910, while the total attendance at the meeting was 1,777.

Much of the success of the Montreal meeting in attracting a large number of visitors from the old country was no doubt due to the exceptional nature of the privileges extended to members of the association by the Canadian authorities. The potential greatness of the resources of the Canadian northwest was not then realized as it is to-day; and the dominion government and people were eager to attract to their shores a representative gathering of the most eminent scientific men in this country who would not only give an impetus to the educational development of Canada, but who would spread on their return home a better knowledge of the greatness of the heritage belonging to the empire in British North America. The privileges extended to the visitors in 1884 might, indeed, well make envious their successors in 1909. They were given free passes over all government railways, over the Canadian Pacific Railway, and over the Canadian Atlantic Railway, while after the meeting a special party of one hundred and fifty members was carried free to the limit of construction of the Canadian Pacific Railway, then open to Stephen, the summit level of the Rocky Mountains. The city of Toronto entertained as its guests after the meeting a party of three hundred members. The transatlantic steamship companies undertook to transmit a limited number of free messages from members to their friends in England, while the overland companies accepted social telegrams for free transmission to all parts of Canada and the United States. The dominion parliament voted a grant of $20,000 as a contribution towards the traveling expenses of the visiting members, and an additional grant of $5,000 was afterwards voted towards the general expenses of the executive committee. The city of Montreal voted $5,000 towards the expenses of the visit, while the subscriptions of private citizens for the same object amounted to $4,820. Thanks to all this public and private generosity, the Canadian committee was able to transmit to the association a sum of $14,000 for the purpose of reducing the cost of members' passages to Canada.

Alike on the social and scientific side the meeting fully justified the faith of its promoters. At the inaugural gathering Lord Rayleigh assumed the presidency of the association, and dealt in his opening address with recent progress in physical science. At this distance of time, it is interesting to note that though Lord Rayleigh was able to describe the lighting of large passenger ships by electricity as already "an assured success," he had also to state that "at present we have no experience of a house-to-house system of illumination (by electric light) on a great scale and in competition with cheap gas; but preparations are already far advanced for trial on an ade-

quate scale in London." The vice-presidents of the meeting included the Governor-General of Canada, Sir John Macdonald (then Premier), Sir Lyon Playfair and Sir Charles Tupper; while among the sectional presidents were Lord Kelvin (then Sir William Thomson), Sir Henry Roscoe and Sir Richard Temple. Others who attended included Sir (then Professor) James Dewar, Admiral Sir Erasmus Ommanney, Dr. W. H. Perkin, Sir (then Mr.) W. H. Preece, Sir (then Professor) Robert Ball, Sir (then Professor) Oliver Lodge and General (then Lieutenant) A. G. Greely, of the United States Army, who was but lately returned from his famous Arctic expedition. It is interesting also to note that in 1884 the association met in only eight sections as compared with the eleven of the present day, physiology, botany and educational science then having no separate sections devoted to their special consideration.

The Toronto meeting, held in August, 1897, was again notable for the lavish hospitality extended to the visiting members of the association by their Canadian hosts. The meeting was not, however, nearly so large as that at Montreal, the attendance numbering only 1,362 members, associates and foreign guests. Otherwise this second trip of the British Association's to the Canadian Dominion was no less successful than the Montreal meeting in giving an impulse to the cultivation of the scientific spirit in Canada and in furthering the spread of imperial sentiments. At the inaugural gathering Sir John Evans, the treasurer of the Royal Society, took over the presidency of the association from Lord Lister; and one of the pleasantest of the social functions was a banquet given in honor of Lord Kelvin, Lord Lister and Sir John Evans. Among the sectional presidents were Sir (then Professor) William Ramsay, Sir (then Professor) Michael Foster and Dr. George Dawson, C.M.G., the late director of the Canadian Geological Survey; while the evening lecturers were Dr. John Milne, Professor W. Chandler Roberts-Austen and Dr. H. O. Forbes.

At Winnipeg, where the association is to hold its meeting this year, the visitors will find themselves in a city which is the living embodiment of the remarkable development of Canada's western prairies during the quarter of a century which has elapsed since the association's first visit to Canada. Less than forty years ago a simple trading post of the Hudson's Bay Company occupied the position where to-day stands the third largest city in the whole Dominion of Canada. In 1870 Winnipeg was a mere outpost of the empire, boasting of a population of 215 souls. When the last census was taken in 1901 the population was 42,000, a sufficiently notable development, but small in comparison with the rapid extension of the city in the last few years. At the end of 1907, according to the handbook which has been issued by the local executive committee in connection with the forthcoming meeting, Winnipeg contained no fewer than 118,000 people. It was only in the spring of 1879 that the city was placed in railway communication with the outer world; and a handy "Souvenir of Winnipeg," issued in connection with the visit of the association to Montreal in 1884, contains as frontispiece a quaint view of the main street, in which the most prominent conveyances are single-horse trams. To-day smart electric trams traverse the city in all directions, and Winnipeg, situated at what has been called the wasp's waist of Canada's railway system, is one of the most important railway centers in the dominion. It is not uninteresting to note some of the statistical facts so proudly quoted in the handbook to which reference has been made as evidence of the extent and importance of the city. Winnipeg, we are there told, has 291 miles of paved and graded streets, 170 miles of water-mains, 675 electric street arc-lights, 29 miles of tramways and 28 schools. Covering an area of 19,000 acres, its total assessable property was valued in 1907 at $106,000,000, or more than double the value in 1904. The output of its manufactures in 1905 was valued at $19,000,000; its bank clearings in 1907 totaled $600,000,000; while as the outlet for the wheat harvest of the Canadian northwest it boasts of being the greatest grain market in the British Empire.

Some particulars have already appeared in *The Times* of June 7 about the local arrangements for the forthcoming meeting. There is every prospect that a considerable body of members of the association will cross the Atlantic, though the inducements which are offered to undertake the journey are nothing like so tempting as in the case in the earlier Canadian meetings. The transatlantic steamship companies have decided that it is impossible to depart from the agreement which exists between them not to make any reduction of fares during August, though so far as possible they are prepared to allot special accommodation to members and associates traveling as first-class passengers. The Canadian railways have arranged to carry members of the British Association party at special rates, generally amounting to a single fare for the double journey. It is impossible, of course, to estimate with exactness the cost of the trip, everything depending on the individual tastes of the visitor and on the length of time he is prepared to spend in Canada.

In no case, however, can the trip be undertaken without a considerable expenditure of time and money. The local committee, without making any allowance for the reduction of railway rates, has estimated that the cost of the return journey, occupying about six weeks from Liverpool, will range from $384 to $500, or say in round figures from £75 to £100, according to the nature of the accommodation required. To meet the expenses of the visit the dominion government has made an appropriation of $25,000, while the city of Winnipeg has voted $5,000. A portion of these grants will be available to lighten the cost of the visit in the case of those taking an active part in the meeting, but the relief thus afforded will only be very small, and necessarily considerations of both time and cost will prevent many of the leaders of scientific thought in this country from undertaking the journey to Winnipeg. Those, however, who do go will, it may be hoped, form a fair representation of British men of science; and the particulars which are now available about the sectional programs afford abundant evidence that on the scientific side the meeting will not fall below the high standard of former gatherings, either in this country or in the colonies.

The president of the association at Winnipeg will be Sir Joseph J. Thomson, F.R.S., Cavendish professor of experimental physics at Cambridge. In his opening address the president will refer to the importance of original research as a means of education, the advantages and disadvantages as a training for work in science of the systems of education now in force in our schools and universities. He will deal with the light thrown by recent investigation on the nature of electricity; on the relation between matter and ether and the part played by the ether in modern physics; and a discussion of some problems raised by the discovery of radium.

THE SMITHSONIAN AFRICAN EXPEDITION

THROUGH the Smithsonian African Expedition under the direction of Mr. Theodore Roosevelt, the National Zoological Park at Washington has been presented by Mr. W. W. McMillan, of Juju Farm, near Nairobi, British East Africa, with an exceptional collection of live African animals.

In a letter recently received at the institution from Lieut. Col. Edgar A. Mearns, of the expedition, it is stated that the collection includes eleven large mammals and three large birds, all in fine condition and for the most part well broken to captivity, as follows: a male and female lion, two years old; a male and two female lions, seventeen months old; a female leopard, a pet of Mrs. McMillan; two cheetahs; a wart hog, two years old; one Thompson's and one Grant's gazelle, well grown; a large eagle of unusual species; a small vulture, and a large Buteo. Specimens of none of these, except the lions and leopard, are at present contained in the park.

The collection is now at the farm near Nairobi. Mr. A. B. Baker, assistant superintendent of the National Zoological Park, has been designated to take charge of its transportation to this country, and for this purpose has sailed from New York on the White Star Line steamer *Arabic*. On his way to Nairobi,

Mr. Baker will stop at London, Hamburg and Mombasa, to perfect details of shipment.

It is intended to secure for the park from Mr. Henry Tarleton, of one of the farms near Nairobi, two Coke's hartebeests, a female water-buck and several zebras, specimens of which are not now owned by the park.

PROFESSOR NEWCOMB'S LIBRARY

The executor of the estate of the late Professor Simon Newcomb (Mrs. Anita Newcomb McGee, 1620 P Street, Washington, D. C.) offers for sale his complete library of books and pamphlets on astronomy, mathematics and allied subjects. During the working years of his life it had been his policy to possess for himself, so far as circumstances allowed, the books necessary in his work. As years passed on it seemed to him that the collection would prove to be of permanent scientific value and he therefore enlarged it by the addition of books which he did not need at the time but which he deemed most useful to the future investigator, especially the student of scientific history. It had been his hope that his library would help in the training of some future great scientist, or in his work. This being his motive, he was especially anxious that the library should not be divided, but should belong to some institution in which astronomical and kindred branches of research are carried on.

With this end in view the value of the library is estimated at only $7,000, which is the estimated cost of the purchased books alone, although the number of transactions of societies and other gift books together with the many thousand pamphlets form a very considerable portion of the value of the library.

There are nearly 4,000 volumes and about 4,000 pamphlets in the library; the pamphlets are all classified and arranged for easy reference and include reprints of memoirs of astronomy, mathematics and physics. In round numbers 1,000 volumes are complete sets of publications of learned societies and observatories.

There is a complete set of Crelle's journal. There are 75–100 catalogues of precision (star-places). The library is especially rich in all branches of astronomy, including popular works, history of astronomy, ancient astronomy, mathematical astronomy, astrophysics, stellar astronomy and photographic astronomy. The large number of volumes on celestial mechanics, including the works of the most celebrated writers is worthy of special mention. The bulk of the library is of course on astronomy and mathematics, the former predominating, but there are also several hundred volumes on physics, geography and meteorology, and many of the transactions cover general science. It is believed that this is the most complete library of its kind in America except, perhaps, that at Harvard University and including the Harvard Observatory library.

In addition to the above and not as yet catalogued, are several hundred—possibly approaching 1,000—books, reports and volumes of periodicals on economic subjects. This is also for sale with or apart from the above.

A typewritten catalogue of this library has been prepared under Professor Newcomb's personal direction in which the works are classified approximately on the system now current in catalogues of astronomical literature. This will be sent to any one contemplating purchase of the collections as a whole. Until about the middle of September the library will remain in place and may be examined.

SCIENTIFIC NOTES AND NEWS

Professor Samuel William Johnson, emeritus professor of agricultural chemistry in Yale University, where he has held a professorship for fifty-three years, a member of the National Academy of Sciences since 1866, past president of the American Chemical Society, eminent for his contributions to agricultural chemistry, died in New Haven on July 21 in his eightieth year.

Professor Newcomb's daughter, Mrs. Anita Newcomb McGee, 1620 P street, Washington, is engaged in the preparation of a biography of her father, and will be most appreciative of any assistance which his friends may render,

such as by sending her letters from him (which will be carefully copied and returned), or by furnishing any information about his life, anecdotes illustrative of character, etc.

DR. AUGUST HOCH, physician to the Bloomingdale Asylum and assistant professor of psychiatry in the Cornell Medical College, is to succeed Dr. Adolf Meyer as director of the Pathological Institute of the New York State Hospitals for the Insane.

As has been noted in SCIENCE, an Academy of Sciences at Heidelberg has been established with an endowment of a million Marks, given by Herr Lanz, of Mannheim. The original members of the academy are the following professors in the university: Bütschli, Curtius, Klebs, Königsberger, Kossel, Lenard, Nissl, Wolf, Wülfing.

THE University of Geneva has conferred on Lord Lister the honorary degree of doctor of medicine.

DR. C. W. STILES, U. S. Public Health and Marine Hospital Service, has been elected a foreign corresponding member of the Academy of Medicine of Turin.

PROFESSOR B. BRAUNER, of Prague, and Mme. Curie, of Paris, have been elected members of the Krakau Academy of Sciences.

MR. J. LUNT, astrophysical assistant at the Cape Observatory, has been given the honorary degree of D.Sc., by the University of Manchester.

THE medical students of Glasgow University met in the Union on June 25 to make a presentation to Professor John Cleland, whose intention to retire from the chair of anatomy, which he has occupied for thirty-two years, has been announced.

DR. CHRISTIANI BÄUMLER, professor of pathology at Freiburg, is about to retire from active service.

DR. WILHELM EBSTEIN, professor of medicine at Göttingen, has celebrated the fiftieth anniversary of his doctorate.

MR. STEPHEN DOWS THAW has been appointed assistant at the Allegheny Observatory, and Mr. Dinsmore Alter has been appointed fellow in astronomy at the same institution.

DR. ALFRED NIPPOLD has been promoted to be observer, and Professor T. H. Arndt to be chief of division in the Meteorological Institute at Berlin.

DR. V. A. MOORE, director of the State Veterinary College, Cornell University, is spending several weeks in Denmark, Germany and England. He is investigating European methods of controlling diseases of cattle.

DR. W. S. BRUCE, of the Scottish Oceanographical Laboratory, Edinburgh, has chartered a steam trawler, and is having her refitted for a scientific expedition to Prince Charles Foreland, Spitzbergen.

THE Christiania correspondent of the London *Times* reports that Dr. Nansen has now completed his preparations for the cruise which he is about to make in northern waters for the purpose of continuing his study of ocean currents and sea temperature, which have an important bearing on the questions of the fisheries and the climate of Norway. The voyage will be made in a small private yacht, which has been furnished with ice sheathing and is otherwise suitably equipped. Dr. Nansen intends to be away till the end of the autumn, and the cruise will cover the Norwegian sea towards Iceland and will possibly be continued to Greenland.

THE Society for the Promotion of Agricultural Science meets at Portland, Ore., on August 17, under the presidency of Professor Thomas F. Hunt, of the Pennsylvania State College.

DR. HERMON C. BUMPUS, director of the American Museum of Natural History, New York; Mr. Gifford Pinchot, United States forester, and Professor J. W. Toumey, of Yale University, were among the speakers in a program of illustrated talks on "Our Forests and their Conservation," given at Bar Harbor on July 27.

FRANK CARNEY, Ph.D. (Cornell), professor of geology in Denison University, delivered a course of lectures on "Geographic Influences" in the University of Virginia during the summer session.

We learn from *Nature* that the first Gustave Canet lecture was delivered by Lieutenant Trevor Dawson at the twenty-fifth anniversary meeting of the Junior Institution of Engineers on June 30. The lecturer is the recipient of the first gold medal, which is to be awarded every fourth year by Madame Canet in memory of her husband, the award being made through the council of the institution.

Mr. A. R. Brown, M.A., fellow of Trinity College, Cambridge, has been appointed Martin White lecturer in ethnology in the University of London for the session of 1909–10.

A bronze memorial tablet in honor of the late Dr. George W. Hough has been unveiled with appropriate exercises in Dearborn Observatory of Northwestern University.

We learn from the *British Medical Journal* that Sir Hector Cameron, on behalf of the committee of subscribers to the fund in memory of the late Dr. James Finlayson, of Glasgrow, has presented a deed of gift to the council of the faculty of Physicians and Surgeons, Glasgow, conveying to the council the future management of the fund. The income from the fund is to be held and applied as the endowment of a lectureship to be called the "Finlayson Memorial Lectureship." The lectures are to deal with pathology, or the practise or history of medicine.

Dr. T. H. Lorenz, docent for mineralogy at Marburg, has died at the age of thirty-four years.

The international committee formed to celebrate the centenary of the publication of Avogadro's memoir on the molecular constitution of gases consists of eminent chemists and physicists throughout the world. The numbers from the different countries having more than one representative, and not including Italy, are: Germany, 23; France, 19; Great Britain, 17; United States, 10; Austria, 8; Holland, 8; Russia, 7; Switzerland, 6; Sweden, 4; Belgium, 3; Denmark, 2, and Norway, 2.

A meteorological and astronomical observation station at an altitude of about 14,000 feet is to be erected on Mount Whitney, California, by the Smithsonian Institution. The work of preparing the trail up the mountain over which the material will be transported by pack mules is already under way. It is expected that the station, which will be temporary, will be completed by the first of September.

The next international congress of mining and metallurgy is to be held in June, 1910, at Dusseldorf. The last congress was at Liége in 1905.

The south, with twenty-seven per cent. of the total area of the United States, contains about forty-two per cent. of the total forest area of the country. The forest area by states is as follows: Alabama, 20,000,000 acres; Arkansas, 24,200,000; Florida, 20,000,000; Georgia, 22,300,000; Kentucky, 10,000,000; Louisiana, 16,500,000; Maryland, 2,200,000; Mississippi, 17,500,000; North Carolina, 19,600,000; South Carolina, 12,000,000; Tennessee, 15,000,000; Texas, 30,000,000; Virginia, 14,000,000 and West Virginia, 9,100,000. The south, it will be seen, has still much of the virgin forest of the country. This forest must be used, of course, in order to meet the steadily expanding wants of this section. It must be used in such a manner, however, that the very most may be made from its annual cut, while at the same time this cut is being replaced by new growth. In this way its timber will remain a source of perpetual wealth. The importance of forest conservation to southern interests is clearly understood by the people of the south. The future of the south is more nearly bound up in the plan of forest preservation, with its accompanying protection to watersheds, power-streams and woodworking industries, than is anything now before the people of this part of the country. Not only is the protection of the watersheds, which will some day furnish the power to run all manufacturing establishments in the entire south, an important matter to the south, but the industries depending upon the forest products will also be benefited by the protection thrown about the remaining timbered area.

The Globe and Commercial Advertiser, New York City, contained recently a truly remarkable article by Mr. E. F. Naulty, the character

of which may be judged from the following editorial introduction: "Edwin F. Naulty, of this city, has recently created lively interest and discussion by his assertions concerning the 'new' comet which he and Dr. Brooks, of Hobart College, announced to the world several weeks ago. Especial interest has attached to Mr. Naulty's statements attributing to the movements of this comet certain disturbing manifestations in nature, such as cyclones, fires and floods—and more particularly the numerous shipwrecks which have puzzled marine experts."

UNIVERSITY AND EDUCATIONAL NEWS

THE five hundredth anniversary of the foundation of the University of Leipzig is being celebrated this week. In addition to banquets and receptions, there are two academic ceremonies. At the first of these addresses are to be made by the rector, Professor Binding, and by the King of Saxony, followed by addresses from delegates; at the second, an address by Professor Wundt, followed by the conferring of honorary degrees.

IT is proposed to establish in connection with the Paris University a system of exchange between French and foreign professors on similar lines to that which obtains between Germany and the United States. M. Liard, rector of the university, has made an appeal to create a fund for the purpose. M. Albert Kahn has placed at the disposal of the rector an annual grant of 30,000 francs for five years.

THE registration for the first term of the summer quarter at the University of Chicago shows a growth in every one of the schools of the institution. The total number registered on July 10 was 2,817, as compared with 2,593 at the end of July, 1908.

AT the University of Chicago associate professors have been appointed from the grade of assistant professors as follows: Carl Kinsley, physics; Chas. M. Child, zoology; Anton J. Carlson, physiology, and H. Gideon Wells, pathology.

ELLIS E. LAWTON, Ph.D. (Yale), who has been professor of physics during the past year in Colby College, has accepted the professorship of physics in Denison University.

MALCOLM E. STICKNEY, for several years assistant professor of botany in Denison University, has been promoted to the full professorship in that subject.

DR. C. E. STROMQUIST, of Princeton University, has been appointed professor of mathematics at the University of Wyoming.

W. E. WENGER, formerly assistant professor of railway engineering in the University of Illinois, has been appointed associate professor in the department of electrical engineering at McGill University.

THE council of King's College has elected Mr. C. G. Barkla, D.Sc., professor of physics, in succession to Professor Harold Wilson, F.R.S., who has accepted the chair in McGill University.

DR. E. KNECHT has been appointed professor of technological chemistry in the University of Manchester.

DR. EDUARD BUCHNER, of the Agricultural School at Berlin, has been appointed professor of chemistry in the University of Breslau, to succeed Professor Ladenburg, who has retired from active service.

DR. FRITZ COHN, astronomer in the Observatory at Königsberg, has been called to a chair of astronomy at Berlin.

DR. VOLKMAR KOHLSCHÜTTER, associate professor of chemistry at Strassburg, has been called to the chair at Bern, vacant by the retirement of Professor Friedheim.

DISCUSSION AND CORRESPONDENCE

A NOMENCLATORIAL COURT?

THE communication of my friend, Mr. Francis N. Balch, on the subject of a nomenclatorial court[1] has been perused with interest by me, not only on account of the novel proposition and the new point of view from which the subject was contemplated, but also because an analogous proposition has been for some years advocated by me in correspondence and conversation regarding zoological nomenclature.

[1] SCIENCE, June 25, pp. 998–1000.

As a lawyer, Mr. Balch does not need to be reminded that there are two sides to every question (else there were no lawyers), and in this case I venture to believe that what is needed is not a court, but more power to our legislature.

Courts have existed since before the days of Hammurabi, say some 5,000 years; yet I read last month in one of the current magazines an article by a Philadelphia lawyer (and his tribe has been proverbial for acumen these hundred years), writing from his own experience, that in the courts of that city the decision in a case of simple fraud was had only after three years delay; and that business men were submitting to robbery or arranging arbitrations, rather than to take the uncertain chances of court justice in that city. And similar complaints in other cities are so common as to excite no interest except in the parties concerned.

We will admit that the complexity of business affairs makes common-sense justice a difficult ideal to attain, yet it seems as if one would not gain much by instituting nomenclatorial courts.

Nomenclature has existed in its binomial form, which alone concerns us, for 150 years, and in its present shape is a development or evolution from more simple conditions. It is common to hear nomenclature treated as an unimportant and unscientific matter, and the discussion of its principles denounced as trivial and unworthy the attention of those capable of research.

On the contrary, I am prepared to maintain the thesis that except the strictly accurate determination of the facts of science and their interrelations, nomenclature is the most important branch of any science. It is not unworthy of the best and most thorough study that clear heads can devote to it. It is, in short, the summation of all the facts of science in systematic form; without a strictly devised nomenclature there could be no science worthy of the name. It is to science, regarded as the facts of the cosmos, what language is to mankind, without which they could not have risen above the brutes.

With a muddled nomenclature nothing can be clear, and, far from being ignored by men of science, this was recognized as early as Adanson in 1757, a year before the tenth edition of Linnæus.

Owing chiefly to the difficulty of prompt intercommunication between scientific men, it was only after posts, railways, etc., began to alter ancient conditions that scientific men began to get together on general questions of nomenclature. In 1842 the result of some years of discussion was the appointment of a legislature, in the form of a British Association Committee, to prepare laws and formulate the rules of practise which had grown up by a sort of common consent. There was then, as now, a certain number of dissidents, but they did not count for much. This legislature was British, but its code was adopted at once by the American Association and very shortly by the scientists of all civilized countries.

A truly international status was given to the code, when the committee of the International Zoological Congress to consider nomenclature was appointed. This committee has met the growing complexity of the subject in the most satisfactory manner, though by necessity always a little behind the growth of the science. A person can not be considered competent to discuss nomenclature unless he knows and understands the rules of the international code. Many do not, yet "rush in," hence much unnecessary controversy.

The object of this legislature has been to make a series of rules (=laws) which any intelligent person by careful study can utilize to settle nomenclatorial questions. The cases which can not be settled by a rigid application of the code are rare. There are some such and they arise chiefly out of the existence of certain scientific works or systems which appeared in the formative period of nomenclature and about which the question arises, "Are they to be accepted as binomial?" or, "Should they, being binomial, but long obsolete or practically unknown, be admitted to disturb names which, though not entitled by the code to stand, have yet become useful through familiarity?"

Now there are a few works in this category which might be brought before our legislature (International Committee) to which I should be willing to give the power to say arbitrarily, "This book or the names in it shall not (or shall) be considered in nomenclature," on petition as to books of this category. I am not sure that much good would result, for the application of the code has been made in so many instances that the dubitable names are already more familiar to the younger men than those they replace. Still the main point is to gain stability and have the question settled definitely one way or the other; so I have for some time favored giving to the international committee the despotic power I have indicated in addition to those they already possess.

In regard to the particular instance referred to by Mr. Balch, it is sufficient to say that the question is already settled definitely by the code, where Mr. Jukes-Brown will find the answer when he becomes familiar with that body of laws. His uncertainty reminds one of the lady lawyer who, finding herself puzzled in the course of an argument, appealed to the late Chief Justice Wylie, who was hearing the case, as to what course she should pursue, and was dryly advised to consult a good lawyer.

One other question has recently been raised in SCIENCE about which a word may be proper here. That is about the use of personal specific names. The objection to them comes chiefly from those who have not yet fully appreciated the axiom that "a name is a name and not a definition." They have become commoner because the Latin adjectives in genera of many species are largely already in use, and a personal name is much less likely to prove a synonym. Further than that it is a mere question of personal taste.

WM. H. DALL

June 28, 1909

THE COMPARATIVE ENROLMENT OF STUDENTS OF ENGINEERING

TO THE EDITOR OF SCIENCE: The communication by Mr. Tombo in the issue of SCIENCE for June 4 is interesting as showing the increase or decrease in registration at the particular institutions mentioned, but it is hardly fair to draw conclusions for the entire country unless the engineering students at all institutions are included.

For instance, the total increase of 1.15 per cent. is changed by one third of its value if the University of Pennsylvania be included in the count. The enrolment at that institution for 1907–8 was 748; for 1908–9 it was 811; the increase is 63 or 8.4 per cent. As the school in question has the finest engineering building in the country and the most modern equipment and as its increase was only exceeded by two schools in the published list, it is not clear why it was omitted in the count.

It is to be noted also that only one school south of the Ohio River is considered. The total might be substantially changed by including that half of the country.

It is hardly fair, too, to infer a general trend from figures for a year following a period of financial and industrial depression.

M. G. LLOYD

THE omission of the University of Pennsylvania in the table was entirely due to inadvertence. This institution was on the list originally prepared by me, and either my letter to them or their report to me must have gone astray in the mails, and in preparing the final table I failed to note the omission. The enrolment of the engineering schools of the University of Pennsylvania for 1907–8 was 748, for 1908–9 it was 811, thus showing an increase of 64 students or of 8.4 per cent. In size, therefore, the school of this institution would rank eighth among the schools contained in the table. There was no intention to draw conclusions for the entire country, but I see no objection to inferring a general trend from figures giving the enrolment of two dozen representative institutions. So far as the southern schools are concerned they are, speaking broadly, not as important as those included in the table, and furthermore, although efforts were made to secure the figures of the most important of these schools, it

failed to comply with my request. Mr. Lloyd is no doubt correct in attributing the decrease in attendance at a number of the institutions to the financial and industrial depression of the preceding year.

I might point out in this connection that it seems rather unfortunate that separate enrolment figures for the technological schools are not given in the annual reports of the United States Commissioner of Education, such as are given, for example, for theology, law, medicine, dentistry, pharmacy, etc. I appreciate the difficulty of distinguishing between pure technological students and academic students who are candidates for a degree in science, but it seems to me that it would be eminently worth while to prevail upon the reporting institutions to make this distinction in future. A table illustrating the changes in the attendance on the engineering schools of our country similar to that found on page 777 of volume 2 of the Report of the Commissioner of Education for 1908, which covers theology, law, medicine, dentistry and pharmacy, would be of great value and deep interest.

RUDOLF TOMBO, JR.

SCIENTIFIC BOOKS

Psychotherapy. By H. MÜNSTERBERG, M.D., Ph.D., Litt.D., LL.D. New York, Moffat, Yard & Co. 1909. Pp. 401.

In an article touching on the popular propaganda for child-study, Münsterberg wrote ten years ago in the *Atlantic Monthly*[1]

> I have always found psychology silent as a sphinx when I came to her with the question of what we ought to do in the walks of practical life.

He has now turned to a very different attitude. In a series of books he discusses, for a wider public, the practical applications of modern psychology. The present volume deals with the relations of psychology to medicine, and aims to reach a wider public, physicians, ministers and all who are in practical contact with the important question of psychotherapy. It is not meant to have the form of loose popular essays, a form preferred where wide attention is to be attracted to a new topic, as in last year's presentation of the work of Stern and Jung and others as psychology applied to witnesses. It is to deal with the whole cycle of the over-popularized problems of psychotherapy "in a serious systematic way and to emphasize the aspect of scientific psychological theory." A worthy aim is to strengthen the public feeling that the time has come when every physician should systematically study psychology, the normal psychology in the college years and the abnormal in the medical school. Scientific medicine should take hold of psychotherapeutics now, or a most deplorable disorganization will set in.

[1] Vol. 85, p. 661.

This is a rather complex and difficult problem. Psychotherapy is in the air and wildly exploited in the book-market and in magazines. Every new book is devoured with avidity by a heterogeneous set of readers prompted as a rule by curiosity or eagerness to get a few helps to bolster up their own theories and exploitations. I see the book in the hands of utterly untrained persons, whose "practical contact with these important questions" is chiefly the desire for self-help or the promptings of curiosity. This is inevitable for a series of books "for a wider public."

Münsterberg says in his preface:

> To those who seek a discussion of life facts alone, the whole first part will, of course, appear to be a tedious way around; they may turn directly to the second and third parts.

I can not help feeling that the average reader will go directly at the chapters with the records of cases only, so that we should really review the book from three standpoints: Its efficiency (1) as a serious unit; (2) as a presentation of facts for those who would as well forego the trouble of a careful digestion of the real principles, and pass over a really most valuable part of the book, and (3) the efficiency of the book from the point of view of a collection of case records.

This may make the author responsible for the inevitable. But where the author himself realizes that he invites certain readers to make a partial use of the book only, his responsibility is admitted. I must leave the verdict to him and the critical readers.

Instead of starting from the simpler facts which everybody can experience, and possibly try, to the more complex phenomena which the majority will have to be satisfied to be able to merely "understand"—or let alone—Münsterberg takes the reader first through a "painstaking and perhaps fatiguing inquiry into principles, before the facts are reached"; chapters on the aim of psychology, mind and brain, psychology and medicine, a chapter on suggestion and hypnotism and a discussion of the subconscious (which is rather dramatically eliminated by the three words "there is none," but after all rather fully discussed). A statement of the simple and plain facts and then a reply to the probable queries of the unsophisticated and the sophisticated varieties of readers would have been more illuminative and more likely to bring home necessary principles to readers who should get them in direct proportion to their eagerness to take in the stories and facts.

In the second part Münsterberg discusses first the field of psychotherapy, the general and special methods, and only after that the mental and bodily symptoms (or facts to be dealt with); he introduces the concrete instances as mere examples instead of a starting point of demonstration and analysis and the principal reason for a discussion.

The third part is devoted to the discussion of the place of psychotherapy in its relation to the church, to the physician and to the community, with a thoroughly sane standpoint and with interesting perspectives.

The effect of the book on physicians, from what I have gathered from a number of inquiries, has been somewhat disappointing. The book has not the breadth of the presentations by physicians like Forel, Moll, Löwenfeld and others; the examples of psychotherapy are chiefly enumerations of cures with profuse expressions of gratitude, without enough reference to failures and to their number and reasons, and without always satisfying the physician to the point of helpfulness. We can safely say that the *medical* contribution is chiefly that of great optimism, and the somewhat dramatic examples frequently a comment on the narrowness and limitation of the thereapeutic fund of most physicians, but too exclusively selected from among the successes. The *theoretical* discussions are in the main sound and in many points unusually helpful and suggestive, but unnecessarily loaded with difficulties of Münsterberg's own making. To some of us it must seem unfortunate to see the undue contrast between psychiatry and psychotherapy ("psychotherapy is sharply to be separated from psychiatry," whereas the fact is that just now many psychopathologists know little psychiatry and many psychiatrists little psychopathology, but for reasons extraneous to the real principles), and the over-emphasis of the contrast of "the attitude of appreciation" and "the attitude of physical explanation," the contrast of the subjective and objective, of the purposive and the causal view—which is raising a string of difficulties which might be dispelled rather than emphasized; further such claims as:

> Whatever belongs to the psychical world can never be linked by a real insight into necessity. Causality there remains an empty name without promise of a real explanation (p. 32).

We are practically made to believe (p. 43) that translation of the facts into neurological terms furnishes the only real explanatory ground. Is not the rôle of the psychophysical doctrine chiefly that of eliminating *harmful features* of a dualistic standpoint which hardly would present itself to a well-guided observer of the simple and plain facts? Does it not call for mere neurologizing tautologies unless we know much more about neuro-physiology?

A plausible and attractive presentation of the problem of attention relieves the start with sensationalism and association psychology. In the "psychophysical" scheme (p. 50) the *quality* of the "elements" is traced to the local position and connection of the brain cells, the *intensity* corresponds to the energy of the excitement; and the *vividness* to the relation of motor channels. But then the reader must wrestle with the claim that "psychology must destroy unity and freedom of our personality" (p. 51)—probably because "any will which is not understood as deter-

mined by causes is simply an unsolved problem"? Owing to the *possible* confusion of morality and mentality the reader is forced to see that the physician and psychotherapist must use his weapons quite irrespective of what he knows chiefly from the *purposive* point of view of experience; a word of encouragement, such as "my friend, be courageous and faithful," is said to be used differently by the physician from what the layman or the minister has in mind, viz., merely as natural and psychophysical material to secure a certain effect, just as sodium bromide would be used. Why this appearance of insincere elimination of the inevitable human feature of a useful reaction, and this reduction to a cold-blooded "scientific" spirit? I grant that "The highest moral appeal may be even a most unfit method of treatment and the religious emotion may just as well do harm as good from the point of view of the physician" (p. 84); but may not equally miscalculated "causal" use of mental suggestion and similarly uncritical uses of supposedly "efficient stimuli" be as harmful? It is not so much the standpoint that makes the trouble, but certain improprieties and the possible disregard of experience. Difficulties concerning the relation of the morbid manifestations and the "underlying" factors are awkwardly introduced in the frequent emphasis of the contrast between "disease" and "symptom":

> The mind reflects only symptoms of the disease; the disease itself belongs always to the organism.

How about the mind and the symptoms? What does this contrast mean in hysteria? Are not the "symptoms" the factors to be handled and practically all we know of the "disease"? I do not deny that a certain medical attitude gets a useful background through these distinctions. But it is an attitude which creates more confusion than good, and which some of us are trying to make unnecessary without surrender of scientific principles. A distinction between leading or essential facts and incidental or accidental ones does more for clearness than the distinction of disease and symptoms.

The chapters on suggestion and hypnotism and on the subconscious are the climax of the introductory part. In the former the actual constructive material is very profitable and might have been given the lead to the extent that the negative character of the key-note of the latter chapter—"There is no subconsciousness" might readily have become the inevitable conclusion, instead of appearing like a quibbling over terms, to one who may have used the expression in a sense more justified than the one criticized by Münsterberg. The positive contribution of these two chapters belongs to the best the book offers. It reduces suggestion to the principle of suppression of opposite tendencies and impulses and wishes, shows that there is no action which has not its definite opposite, and that the induction of opposite mental states constitutes the eliminative and curative power in suggestion. Münsterberg shows how this same principle holds also for attention; how attention leads to making the object clearer, while in suggestion we change it in adapting ourselves to the new situation in which we believe (since *actions* and *beliefs* are the only possible material of any suggestion). He shows that there is nowhere a sharp line between receiving communications and receiving suggestions, just as attention shades over into neutral perception.

> It is in the highest interests of psychotherapy that this intimate connection between suggestion and ordinary talk and intercourse, between suggestion and ordinary choice of motives, between suggestion and attention be steadily kept in view and that suggestion is not transformed into a kind of mysterious agency.

This discussion is most admirable. The same form of constructive procedure might very efficiently have kept out the contrasts of moral and mental, etc., criticized above, where only a *wrong method* of dealing with the contrasted matters is the issue (see also p. 374), and the contrast as such is relatively unessential.

The subconscious is done away with. Subconscious mental facts are either not mental but physiological, or mental but not subconscious. Too much emphasis is put on the

"conscious" which evidently is after all used merely as a synonym of "mental." Too little is made of the nature and mode of dissociation and the biology of dissociated complexes, to give the average reader matter for a less misleading reconstruction of what he now stores in the subconscious. With a frank acceptance of biological principles the interesting but probably somewhat bewildering discussion could be greatly simplified. When the reader has successfully divested himself of the over-emphasis of the concept of consciousness—which as we know can hardly be found discussed in modern text-books on psychology—he is again brought up to it on p. 154:

> But again we have even in such most complex and exceptional cases only an alternation in the contents, not an alternation in the consciousness itself.

If consciousness denotes chiefly the mental character of the reaction, why should we go on contrasting "contents" and "consciousness"? If it designates degrees of connections, why deny the alternations? Nothwithstanding these criticisms, the two chapters are a most excellent *pièce de résistance* of the book.

The second part of the book, the field of psychotherapy, its general and special methods, and the mental and bodily symptoms, is better than similar popularizations. To the physician and even more to the layman, the casuistic material brings much encouragement, but probably also a false perspective, although no doubt less so than many other attempts of propaganda. To one familiar with what has been achieved during the last twenty-five years, psychotherapy must appear rather broader than is depicted in the case-records. The book makes it a point to abstain from everything which is exceptional or even unusual; yet, it does not make plain in the cases, how much can be corrected by a simple adjustment of conduct and attitude (without hypnotism or other very specific methods); or why the method employed is necessarily cogent. After all the book claims to sketch the whole field of disturbances in which psychotherapeutic influences might be possible and all the methods available.

There lies a great danger in such an attempt of writing popularly about a matter of action and procedure without a full discussion of the principles and factors to be handled. What should we think of a book on drug-treatment for a general public unless it analyzed the things to be treated and some indications of *why* the matter and choice of method must after all be left to the physician? Münsterberg urges that these matters be left to the physician and he even condemns the running of a "psychological clinic" by a non-medical psychologist. Why then discuss the whole procedure before the wider public?

It might be easy to misinterpret the protestations that the writer would never use hypnotism experimentally (p. 380). They tend to give an idea that there must be something wrong or dangerous or queer in it, after all, even in the hands of a competent M.D. We certainly should not hesitate to try drugs on ourselves or others to study physiological effects and especially their harmlessness. This feature of the third part of the book, and such sentences as "It is never the task of the minister to heal a mind and never the task of a physician to uplift a mind. One moves in the purposive sphere, the other in the causal sphere"—and the continual dogmatic discrimination against psychiatry in which psychotherapy (though not merely hypnotism and tricks) is daily more essential, might well be modified in further editions.

It is a pity that the book is intended to serve for propaganda to so many classes. A book frankly addressed to physicians, and another frankly addressed to the layman would have been safer and more acceptable.

ADOLF MEYER

Anwendung elementarer Mathematik auf biologische Probleme. H. PRZIBRAM. Leipzig, Engelmann. 1908. Pp. vi + 84. (Forming Heft III. of Vorträge und Aufsätze über Entwicklungsmechanik der Organismen.)

The purpose of this book is stated at the outstart by the author to be an attempt to show biologists that a mathematical treatment of biological problems may be in general valid and useful. By such demonstration it is hoped to lessen or eradicate "eine gewisse Scheu" of such methods on the part of workers in this field, which Przibram (in common with others) has observed. Both these aims are certainly commendable, and this book will undoubtedly aid—and in certain quarters perhaps greatly aid—in their realization.

The general plan of the book, which is an outgrowth of a series of lectures given in the University of Vienna, is to present first in an introductory chapter certain general considerations regarding the scope, the limitations, the necessity for and the practical usefulness of mathematical methods in biological investigation. There follows a series of chapters intended to show how the general principles brought out in the introductory chapter apply in the study of specific, concrete, biological problems. In the practical working out of this scheme it results that the introductory chapter, with the title "Möglichkeit mathematischer Biologie," is by long odds the best in the book. The arguments for the possibility, and indeed necessity, of a mathematical biology are stated very clearly, incisively and convincingly. To be sure, such arguments have been as well stated before, but it is encouraging, and augurs well for the wider acceptance of these ideas, that this time they are presented by a biologist *von Fach*, not by a mathematician.

The special chapters (II. to IX. inclusive) deal with a variety of general biological problems from the standpoint noted above. Chapter II. (Raum) discusses the interrelations between cell and nuclear volume and surface. Chapter III. (Zeit und Geschwindigkeit) deals primarily with growth and in particular with rate of growth. Chapter IV. (Energie) has as its chief topic the temperature coefficients of various biological phenomena. Gleichgewicht is the title of Chapter V. and it deals with certain quantitative aspects of regeneration and molting in arthropods. The next chapter has for its title Chance and for its biological topic the distribution (right or left) of asymmetry of the chelæ in certain crustacea. As a supplement to this chapter there is a brief discussion of sex as a "chance" phenomenon. Chapter VII., under the title Kombinationen, deals with the segregation and recombination of characters in Mendelian inheritance. Variation und Selektion are briefly discussed in the next chapter. Chapter IX. deals in an elementary way with psychophysics, particular attention being given to the Weber-Fechner law. A curiously ill-assorted and incomplete bibliography ends the volume. The author states in the preface that the bibliography is not complete. How superfluous this remark is is indicated, for example, by the fact that Pearson's name does not appear at all except as an associate editor of *Biometrika*, and that Weldon is known only by his 1898 British Association address. Whatever one's opinion may be as to the importance of Pearson's work, it certainly is a fact that he has contributed extensively to the subject with which this book has to do, viz., the application of elementary mathematics to biological problems. That Przibram is aware of this fact appears definitely in the text. To cite Pearson's fundamental papers in the bibliography would seem only common justice to the reader.

The discussions in these special chapters are in every case suggestive. They are, however, neither exhaustive nor thorough. But since they were obviously not intended to be they perhaps can not fairly be criticized on this ground. The greatest weakness of these chapters, to the reviewer's way of thinking, is that the standpoint is too exclusively abstract and too little concrete and *quantitative*. Biology needs definite, quantitative data bearing on its problems, much more than it does theoretical abstractions, even though these be mathematical in form. Of course it is not to be expected that measurements or statistics will be presented in a general work of this character; but it is reasonable to ask that the general

standpoint of the work give no excuse for even the most careless reader to carry away the notion that a deft manipulation of equations will *per se* ever solve a biological problem. On the whole the book is an interesting and suggestive introduction to the general subject of "mathematical biology."

RAYMOND PEARL

Archiv für Zellforschung. Herausgegeben von Dr. RICHARD GOLDSCHMIDT, München. Leipzig, Verlag von Wilhelm Engelmann.

Cytology has grown so rapidly within the last decade that it is already one of the important subdivisions of biology and the journals devoted to morphology and physiology are no longer able to provide for the publication of the constantly increasing output of research in this field. Furthermore in the study of the cell, which is the ultimate independent unit of all organic structure and function, the subdivisions of biology into botany and zoology, morphology and physiology, have less value than in the study of less general structures and functions; in the study of the cell all biological sciences come to a focus, the cytologist is not, or at least should not be, exclusively a zoologist, a botanist, a morphologist or a physiologist, but all of these combined. The scattering of cytological literature through the journals of all of these special sciences makes it much less accessible to the student of the cell and tends to emphasize distinctions which are here worse than useless. Finally the problems of cytology are of such general and fundamental interest that they well deserve and should well support special publications in this field.

Almost twenty-five years ago the late Professor Carnoy established the journal *La Cellule,* which has ever since continued to be published in beautiful and sumptious form; from the first, however, it was devoted very largely to the work of Carnoy and his pupils and its *raison d'etre* was the propagation of the views of a particular school. Of late there has been very urgent and increasing need of a general journal devoted exclusively to cytology and representing no particular school or propaganda. Such a journal is the *Archiv für Zellforschung,* edited by Dr. Richard Goldschmidt, of Munich, and published by W. Engelmann, of Leipzig. The first number of this journal appeared in February, 1908, and the first volume, consisting of four numbers, was completed in July of the same year; a second volume has appeared since then. Each volume consists of about 600 pages and 20 lithographic double-plates, with numerous text figures. The *Archiv* receives and publishes contributions in the German, French, English and Italian languages, supplies authors with 40 separata gratis, and pays an honorarium of 40 Marks per signature of sixteen pages for contributions of not more than four signatures. In paper, typography and illustrations the new journal shows the usual German excellence, while the character of the contributions is of a very high order, as is indicated by the following lists of contents of the first volume: Richard Hertwig, "Ueber neue Probleme der Zellenlehre"; G. Tischler, "Zellstudien an sterilen Bastardpflanzen"; A. und K. E. Schreiner, "Zur Spermienbildung der Myxinoiden"; Richard Goldschmidt, "Ueber das Verhalten des Chromatins bei der Eireifung und Befruchtung des *Dicrocœlium lanceatum;* Methodi Popoff, Experimentelle Zellstudien"; M. G. Sykes, "Nuclear Division in *Funkia";* J. Duesenberg, "Les divisions des Spermatocytes chez le Rat"; Kristine Bonnevie, "Chromosomenstudien"; M. G. Sykes, "Note on the Number of the Somatic Chromosomes in *Funkia";* Honoré Lams, "Les divisions des Spermatocytes chez la Fourmi (*Camponotus herculaneus*)"; Alfred Kühn, "Die Entwicklung der Keimzellen in der parthenogenetischen Generationen der Cladoceren *Daphnia pulex";* Vladislav Ruzicka, "Zur Kentnis der Natur und Bedeutung des Plastins"; R. Fick, "Zur Konjugation der Chromosomen"; Friedr. Meves, "Es gibt keine parallele Konjugation der Chromosomen!" R. Goldschmidt, "Ist eine parallele Chromosomenkonjugation bewiesen?"

The second volume is equally meritorious, and the abundance of such excellent contribu-

tions indicates how great has been the need for such a journal, and by the same showing this journal is one which no cytologist can afford to be without.

E. G. Conklin

BOTANICAL NOTES

CYTOLOGY, EMBRYOLOGY AND HISTOLOGY

Dr. Miyake's studies of "The Development of Gametophytes and Embryogeny of Cunninghamia" (*Bot. Mag.*, March, 1908) leads him to the conclusion that there is a close affinity between this genus and *Taxodium* and *Cryptomeria*. He suggests that these genera should be placed with the Cupresseae, "and that *Sequoia* and *Sciadopytis* should each constitute a family by itself."

Helen Dorety in studying "The Embryo of Ceratozamia" (*Bot. Gaz.*, June, 1908) in which there is but one cotyledon, subjected the young ovules to the action of a klinostat (thus neutralizing the effect of gravitation) and found that embryos grown under these conditions developed two cotyledons. These studies are continued in a later paper, "The Seedling of Ceratozamia" (*Bot. Gaz.*, September, 1908).

Here may be mentioned R. J. Pool's "Histological Studies in the Artemisia Formation" (*Univ. Nebr. Studies*, Vol. 8, No. 4), in which further facts are recorded in regard to the relation between the physical environment of plants and their internal structure. Especial attention was given to *Artemisia tridentata*, the "sage brush" of the Rocky Mountain region, a perennial, woody xerophyte, although some attention was given to twenty-four other species of plants which occur in the formation. Eight plates, including forty-two figures, accompany the paper.

In R. H. Pond's studies of the "Emergence of Lateral Roots" (*Bot. Gaz.*, Vol. 46, pp. 410–12) the author concludes that in *Vicia faba* and *Lupinus albus* they "push out from the central cylinder mechanically, and do not have a digestive action upon the surrounding tissue."

In the same number of the *Gazette* W. H. Brown's paper on "The Nature of the Embryo-sac of Peperomia" contributes additional facts to our knowledge of a genus of interesting plants. Among his results are the heterotypic division of the embryo-sac nucleus, and the mature sac with sixteen nuclei. Three fine plates add to the value of the paper.

We may note, also, Dr. Swingle's "Embryology of *Myosurus minimus*" (*Am. Nat.*, September, 1908) and L. L. Burlingame's "Staminate Cone and Male Gametophyte of *Podocarpus*" (*Bot. Gaz.*, September, 1908), both of which add somewhat to our knowledge of the plants concerned.

THE GRAPES OF NEW YORK

Some years ago the New York Agricultural Experiment Station began the publication of a series of comprehensive treatises on the fruits of New York, the first, devoted to the apples, being the work of Professor S. A. Beach. Now we have from U. P. Hedrick and his four assistants a thick quarto volume of nearly six hundred pages, and 101 full-page color-plates. The latter are remarkably fine, and were made by a four-color process in which four photographic negatives were made of each specimen, and from these four copper plates were made, and in the printing each plate was used for one of the four colors used, viz., red, yellow, black and blue. It is by far the best work of this kind that we have seen.

The volume is of much more than horticultural interest, and will be consulted by botanists who wish to know something of the relationship of the various kinds of grapes more or less commonly grown in the northern states. There is first an interesting account of the old world grape (*Vitis vinifera*), and of the many futile attempts to introduce it into North America east of the Rocky Mountains. Then follows a similar, but longer account of the American grapes and their introduction into cultivation. The next chapter on Viticulture in New York is devoted to the practical horticultural aspects of the subject, and this is followed by one wholly botanical in which twenty-three American species are described with much particularity. References

to the literature and published accounts of each species are given with much fulness, and where the species has been brought under cultivation the history of such introduction is given. This chapter represents much prolonged and careful work on the part of the author and his assistants. The bulk of the book is taken up with descriptions of the leading varieties of American grapes, arranged in alphabetical order. The author's suggestions as to the specific origin of each variety are of interest to the botanist, who will be surprised to find that so many are of hybrid origin. In some cases the varieties are not simple hybrids, but combine the "blood" of three or even four species. On the other hand, not a few varieties are derived from a single original species. Thus the well-known "Concord" variety is considered to belong to the species *Vitis labrusca*, without any other admixture. The "Catawba" is regarded as a hybrid between *V. labrusca* and *V. vinifera* as is also the "Isabella." In order to produce the toothsome "Delaware" no less than three species have been blended, viz., *V. labrusca*, *V. bourquiniana* and *V. vinifera*.

Following this chapter is one enumerating the minor varieties of American grapes, and the volume ends with a bibliography and a good index. Altogether it is a most interesting and valuable volume for the horticulturist, while at the same time it is so well written from the scientific standpoint that it must become a valuable reference book for the botanist.

A BOTANICAL OPPORTUNITY

DURING his very active life the late Professor William A. Kellerman made large collections of plants amounting to many thousands of specimens, which are still the property of his estate. These are now for sale, and an unusual opportunity is thus opened to museums for securing a herbarium of great value. There are approximately 30,000 mounted specimens of flowering plants, with about as many more that are unmounted, and 40,000 mounted specimens of parasitic plants (fungi) and an equal number or perhaps more of unmounted specimens. Altogether there are thus not far from sixty thousand mounted specimens, and from sixty to seventy thousand that are unmounted.

The collections are said to be in good condition, care having been taken to use the best methods for their preservation by adequate protection against dust and moisture, while insect depredations have been guarded against by poisoning and other means.

The fact that Professor Kellerman collected much of this material while making his careful studies of the harmful fungi which affect cultivated plants gives to this collection great value for the plant pathologist. It would be invaluable for any one of our more scientific experiment stations. Since many of the specimens were collected in Central America, this fact will appeal to the curators of the large herbaria connected with the great universities. In fact a considerable collection of plants like this, which represents the life-work of an active botanist, must have a high value on that account, alone, to say nothing of its value for the species represented.

Mrs. Kellerman hopes to have these collections kept together, as indeed they should be, if possible, but they will be sold separately if necessary. Here is an opportunity for some one who wishes to help botanical science in this country by the purchase of these collections for some institution. They should be kept together if possible, as the "Kellerman Herbarium," but whether kept together or merged into some larger herbarium, they should be made available for the use of botanical students. There must be many men of scientific tastes who would be glad to render a service to science by the presentation of this herbarium to the botanical department of some university or to one of our botanical gardens. The editor of these notes hopes that what is here said may suggest to some of the readers of SCIENCE a use for a few thousand dollars that will render a lasting service to American botany. Moreover, the editor will be glad to aid in bringing about such a desirable scientific benevolence.

CHARLES E. BESSEY
THE UNIVERSITY OF NEBRASKA

THE GROWTH OF NERVE FIBERS

THE view that each nerve fiber develops as an independent outgrowth from a nerve-cell, finally becoming united to other tissues (*e. g.*, muscle fibers) in the periphery of the body is associated especially with the name of His, and has been accepted by the majority of embryologists. Those who have worked at the question of nerve repair or have studied the mechanism of the regeneration of nerve fibers which leads to restoration of functions are divided into two camps; the majority hold, as Waller originally taught, that the nerve fibers grow in a distal direction from the cut stump attached to the central nervous system, ultimately finding their way into the peripheral segment. A minority of researchers hold the contrary view, namely, that restoration occurs in the peripheral segment independently of connection with the central nervous system.

Within the last year, Mr. Ross Harrison, of Yale, has demonstrated the correctness of the views of His in a very remarkable way. He has actually seen the fibers growing outwards in embryonic structures. Pieces of the primitive nervous tube which forms the central nervous system were removed from frog embryos and kept alive in a drop of lymph for a very considerable time; the cilia of the neighboring epidermic cells remained active for a week or more; embryonic mesoblastic cells in the vicinity were seen to become transformed into striated muscular fibers, and there was therefore no doubt that even under these artificial conditions—rendered necessary for microscopic purposes—life and growth were continuing. From the primitive nervous tissue, and from this alone, nerve fibers were observed growing and extending into the surrounding parts. Each fiber shows faint fibrillation, but its most remarkable feature is its enlarged end, which exhibits a continual change of form. This amœboid movement is very active, and it results in drawing out and lengthening the fiber to which it is attached, and the length of the fiber increases at the rate of about 1 micromillimeter per minute. Those interested in this subject should refer to Mr. Harrison's last paper, published in the *Anatomical Record* (Philadelphia, December, 1908), where they will find figures representing the growing fibers in various lengths drawn at intervals of half an hour or thereabouts.

Such observations show beyond question that the nerve fiber develops by the overflowing of protoplasm from the central cells and thus give us direct ocular evidence in favor of the view which most embryologists previously held mainly as the result of circumstantial evidence. It is not surprising to find that as this and other facts all bearing in the same direction are brought to light, the prevalent idea regarding nerve regeneration after injury follows the same lines. Indeed, the number of those who hold the so-called "autogenetic theory" of nerve regeneration is being reduced nearly to vanishing point.—*Nature*.

SPECIAL ARTICLES

HYDROGEN POLYSULPHIDE AS A REDUCING AGENT

WHEN lime and "flowers of sulphur" are boiled with water and the resulting cooled, clear solution poured into dilute hydrochloric acid, a heavy colored liquid separates. This liquid is stated by some chemists to be an impure hydrogen polysulphide, whereas others regard it as a mixture of several hydrogen polysulphides.

The substance has well-developed reducing properties and I have found that its employment in organic work appears to offer considerable advantages in many cases.

The chief merits of hydrogen polysulphide, as compared with ordinary reducing agents, are as follows: It is neutral; it may be used at the ordinary temperature, dissolved in ionizing solvents such as water or alcohol, or in nonionizing media such as carbon bisulphide. The exact quantity of hydrogen polysulphide present in any of its solutions may be determined with great ease by titration with iodine.

At the ordinary temperature, hydrogen polysulphide reduces picric acid to picramic acid. With nitrobenzene its reaction appears to be somewhat more complicated. Further work on this subject and also on the general applicability of hydrogen polysulphide as a reducing agent is being carried out in the chem-

ical laboratory of the McMaster University, Toronto, Canada.

ALFRED TINGLE
LABORATORY OF THE CHIH LI BUREAU AND
THE IMPERIAL CHINESE PEI YANG MINT,
TIENTSIN, April 11, 1909

SOCIETIES AND ACADEMIES

THE OHIO ACADEMY OF SCIENCE

THE eighteenth annual meeting of the academy was held at Denison University, Granville, O., on November 26, 27 and 28, the president of the society, Professor Frank Carney, presiding. On Thursday evening a reception was held at the residence of President and Mrs. Emory W. Hunt, of the University, where a most enjoyable evening was passed by the considerable number of members present. Accommodations for members had been generously made by the university authorities, who had placed the dormitories at the disposal of the society. The sessions were held in Barney Memorial Hall.

The address of the president on "The Raised Beaches of the Berea, Cleveland and Euclid Quadrangles" occurred at 1:30 P.M. Friday, while in the evening, at 7:30, Professor R. S. Tarr, of Cornell University, discussed "The Glaciers of Mount St. Elias and Vicinity," giving an account of his recent trip, which was illustrated by a large number of interesting lantern slides.

A discussion of much practical importance was that on "The Preservation and Development of the Natural Resources of Ohio," the geological side of which was presented by Professor J. A. Bownocker, the forestry side by Professor W. L. Lazenby and the biological side by Professor Herbert Osborn.

The complete program of the meeting was as follows:

"Notes on *Spondylomorum quaternarium* Ehrb.," by M. E. Stickney.

"The Pteridophyte Flora of Ohio," by J. H. Schaffner.

"Injury to Trees by the Season's Drouth," by W. R. Lazenby.

"Snails Collected at Cedar Point, O., during July, 1908," by S. R. Williams and J. K. Breitenbecher.

"The Making of a Naturalist's Directory," by F. J. Hillig.

"The Occurrence of a New Species of Land Planarian in Ohio, with Notes on the Common Species, *Rhynchodemus sylvaticus* Leidy," by L. B. Walton.

"The Behavior of the Opossum (*Didelphys virginiana*)," by G. E. Coghill.

"Differentiation of the General Cutaneous and Visceral Ganglia in *Ameiurus*," by F. L. Landacre.

"Some Aspects of Amitosis in Synchytrium," by R. F. Griggs.

"Direction of Flow of Encephalic Fluid in *Amia calva* L.," by Chas. Brookover.

"Recent Evaporation Investigations," by J. Warren Smith.

"Adaptation in a Desert Lichen Flora," by Bruce Fink.

"Notes on the Ohio Flora," by J. H. Schaffner.

"The Laboratory Method for Beginning Students," by Maximilian Braam.

"Protective Encystment in *Phagocata gracilis*," by L. D. Peaslee.

"Cell Division in the Pollen Mother Cells of *Anthemis cotula* L.," by M. E. Stickney.

"Mitosis in *Opalina*," by M. M. Metcalf.

"A Preliminary Report on the Nuclear Divisions in the Pollen Mother Cell of *Convallaria majalis* L.," by L. W. Sauer.

"Is Synizesis an Artifact?" by J. H. Schaffner.

"A Preliminary Note on the Chondrocranium of *Eumeces*," by E. L. Rice. (Slides.)

"Notes on the Growth of the Western Catalpa (*Catalpa speciosa*)," by W. R. Lazenby.

"Faulty Specimens for Nature Study, and how Good Ones may be Prepared," by Chas. Drury.

"Cancer in Mice (*Mus musculus*)," by E. F. McCampbell.

"Relation of Rainfall to Crop Yield," by J. Warren Smith.

"Removal of the Showy Parts of Flowers as affecting Fruit and Seed Produced," by A. H. McCray.

"The Coals of the Monongahela Formations in Ohio," by J. A. Bownocker.

"Fresh Light on the Chronology of the Glacial Epoch in North America," by G. F. Wright. (Slides.)

"Glacial Erosion in the Canadian Selkirks," by L. G. Westgate. (Slides.)

"Some Effects of Glacial Erosion in the Alps," by N. M. Fenneman.

"The Raised Beaches of Lake Huron," by W. M. Gregory.

"Rock Terraces along Streams in the Vicinity of Columbus, O.," by G. D. Hubbard.

"Ecologic Notes from Beechwood Camp," by Bruce Fink.

"The Systematic Position of *Apathus elatus*," by A. H. McCray.

"Observations on the Tick, *Bryobia pretensis* Garman," by S. R. Williams.

"Occurrence of *Paragonimus westermannii* near Cincinnati, O.," by H. M. Benedict.

"Localization of the Excretory Function in *Amœba proteus*," by M. M. Metcalf and R. A. Budington.

"Evidence pointing toward a Sexual Reproduction in *Euglena*," by L. B. Walton.

"The Discomycetes of Oxford, O.," by Bruce Fink and Freda M. Detmers.

"Observations on Ohio Species of Disonychra," by L. L. Scott.

"Observations on Tube Making in Tubifex," by Cora M. Box.

"Venation of Leaves from Old and Young Plants," by H. M. Benedict.

"Some Noteworthy Species of Plants in Ohio," by O. E. Jennings.

"The Waverly Formations of East Central Kentucky," by W. C. Morse and A. F. Foerste.

"Valley Drift at St. Louisville, O.," by Howard Clark. (Slides.)

"Well Records in Licking County, O.," by Lewis Thomas.

"The Age of the Licking Narrows at Black Hand, O.," by K. F. Mather.

"Post-Glacial Erosion of Plum Creek, Oberlin, O.," by G. F. Wright.

"Glacial Deposits Southwest of Wilkins Run, O.," by Madge Mossman.

"The Teaching of Historical Geology," by L. G. Westgate.

"Preglacial Channels in the Little Miami Valley," by G. F. Wright.

"The Major Subdivisions of the Lower Silurian Strata in Ohio, with Particular Reference to the Richmond Formation recently Mapped by the Ohio Geological Survey," by A. F. Foerste and W. C. Morse.

"The Value of Geology as an Educational Discipline," by L. G. Westgate.

"A New Anthracnose of Cereals and Grasses," by A. D. Selby and T. F. Manus.

"The Reconstruction Method as Applied to Hollow Organs," by E. L. Rice.

Demonstrations

Cytological technique, by M. E. Stickney.

Charts illustrating the reaction of *Diemyctylus* embryos to tactile stimuli, by G. E. Coghill.

Slide showing emergence of the gametes (?) from the small spores arising from the repeated division of an "encysted" *Euglena*, by L. B. Walton.

The "larval" form of an interesting pauropod, *Eurypauropus spinosus* Ryder, by L. B. Walton.

Reports which were adopted were made by various committees, including that on the new constitution and by-laws. This was ordered printed in the *Proceedings* of the academy.

The society adopted resolutions expressing its sense of loss in the deaths of three members since the last annual meeting, William Ashbrook Kellerman, professor of botany at Ohio State University, Hon. Joseph Outhwaite and John J. Janney. The life of Professor Kellerman was sacrificed to science, death resulting from a tropical fever while on a collecting expedition in Guatemala, Central America. He was one of the charter members of the society and had served it as president in 1897, while rarely an annual meeting was held in which his interest was not manifested through his attendance and participation in the program. Both Mr. Outhwaite and Mr. Janney, who were also residents of Columbus, had at various times signified their interest in the affairs of the academy. Mr. Janney died at the advanced age of ninety-six years.

Resolutions were also adopted expressing the appreciation of the society for the courtesies extended by the faculty and others at Denison University, and to members of the local committee, of which Professor George F. McKibben was chairman, for their services in the interest of the academy, and furthermore thanking Mr. Emerson McMillin, of New York, for the continuation of his interest in the welfare of science. The society then adjourned.

The following officers were elected for the coming year:

President—J. H. Schaffner.

Vice-Presidents—L. G. Westgate and S. R. Williams.

Secretary—L. B. Walton.

Treasurer—J. S. Hine.

Librarian—W. C. Mills.

Executive Committee—Ex officio: J. H. Schaffner, Jas. S. Hine and L. B. Walton; elective: Chas. Brookover and J. Warren Smith.

Board of Trustees—W. R. Lazenby, chairman, term expires 1909; Frank Carney, term expires 1910; E. L. Rice, term expires 1911.

Publication Committee—J. C. Hambleton, term expires 1909; E. L. Rice, chairman, term expires 1910; Bruce Fink, term expires 1911.

L. B. WALTON,
Secretary

SCIENCE

FRIDAY, AUGUST 6, 1909

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE CHEMICAL WORK OF THE U. S. GEOLOGICAL SURVEY *

THE present Geological Survey of the United States was organized in 1879. In 1880 a chemical laboratory was established at Denver, Colo., in charge of Dr. W. F. Hillebrand, with whom were associated Mr. Antony Guyard and, later, Mr. L. G. Eakins. In 1882 Dr. W. H. Melville opened a second laboratory at San Francisco, and in the autumn of 1883 the central laboratory at Washington began operations with myself as chief chemist. In November, 1885, Dr. Hillebrand was transferred to Washington; early in 1888 he was followed by Mr. Eakins, and the Denver laboratory was discontinued. In the spring of 1890 Dr. Melville also removed to Washington, and the chemical work of the survey was concentrated at headquarters. In recent years a number of other laboratories have been established for special purposes, and the work done in them will be considered in due order later.

The primary purpose for which the chemists of the survey were employed was to assist the geologists in working up their collections. Analyses were needed for the identification of mineral substances, and they were called for in great numbers. Up to January 1, 1909, more than 6,000 analyses have been recorded upon the books of the central laboratory; covering rocks, minerals, ores, coals, waters, sediments, saline incrustations, etc., and their conduct has necessarily occupied a large share of the time of the chemists.[1] But the field of

* Prepared for the International Congress of Applied Chemistry in London. Published by permission of the Director of the Survey.

[1] Some hundreds of other analyses were made in the Denver and San Francisco laboratories.

work was not limited to analyses alone; problems for research were frequently suggested; and a variety of interesting investigations have been carried out in the survey laboratories. My aim in this communication is to give a brief summary of the results so far obtained, and to indicate something as to their significance.

In the first place, more than one thousand analyses of igneous rocks have been made, and also many partial analyses for special purposes. This work was called for by the petrographers of the survey, and it has led to some unforeseen consequences. In the beginning, the analyses were made along conventional lines and the minor constituents of the rocks were neglected, a policy which is still followed in many European laboratories. It was soon found, however, that greater refinement of the work was desirable, and that in some cases a rock analysis, to be really satisfactory, needed from fifteen to twenty separate determinations. At present the following substances are commonly determined, or at least their absence is proved: silica, alumina, both oxides of iron, magnesia, lime, soda, potash, water at and above 100°, titanic oxide, zirconia, carbonic acid, phosphoric acid, sulphuric acid, sulphur, baryta, strontia, manganese, nickel and chromium; and often also vanadium, chlorine and fluorine. Lithia is sometimes determined, but possible boron and glucina are ignored. The water is always determined directly, never by loss on ignition; and recently, because of the researches of Mauzelius, as verified and extended by Hillebrand, the influence of the fineness or coarseness of the rock powder is taken into account. We now know that in fine grinding, part of the ferrous oxide in a rock or mineral becomes oxidized, and also that notable quantities of water are at the same time absorbed from the atmosphere. The errors thus introduced into an analysis are too large to be neglected. As far as possible the analytical operations are performed in platinum dishes, in order to avoid contaminations derived from glass. Furthermore, all reagents are carefully tested as to their purity. Without these precautions accurate work can hardly be done.

The analyses thus made are evidently much more complete than those collected in Roth's well-known tables, and at the same time their summation is better. To be satisfactory a rock analysis should sum up between 99.50 and 100.50 per cent.; the average summation error of the survey analyses being only 0.20 per cent. The determinations of the minor constitutents not only render the analyses more precise, but also aid the petrographer in his discussion of the data. For example, the average proportion of titanic oxide found in 989 analyses is 0.74, and that of phosphoric oxide is 0.26 per cent., or one per cent. together. If these substances are not determined they render the determination of the alumina too high, and when the petrographer attempts to compute the proportion of feldspar in a rock the error is multiplied several times over. The slight value of analyses in which these determinations are neglected is therefore almost self-evident.

For the work thus done upon the igneous rocks, chief credit must be given to Dr. Hillebrand. He first perceived the importance of more thorough analyses, and did much toward perfecting the analytical methods. His bulletin, "On the Analysis of Silicate and Carbonate Rocks," is already recognized as a classic.[2]

From a small number of rock analyses only minor conclusions can be drawn. They aid the petrographer in the study of his special group of specimens; but, unless they are correlated with other data, they

[2] Bulletin 305, U. S. Geological Survey.

do little towards solving any large problems. When, however, such a mass of fairly homogeneous analyses is at hand as that developed in the laboratories of the survey, it becomes possible to study the geochemistry of the igneous rocks in a broad way, and to shed light upon more than one troublesome question. It is seen, for instance, that the minor constituents of the rocks represent a wide diffusion of many chemical elements, whose presence was formerly regarded as insignificant. From an average of the analyses the mean composition of the igneous crust of the earth can be determined, and it then appears that titanium, hitherto unimportant, is really the ninth in point of abundance among all the chemical elements. Oxygen comes first, forming almost one half of all the matter present in the outer ten miles of the earth's crust; then follows silicon, about 25 per cent.; then aluminum, iron and calcium, in the order named. Magnesium, sodium and potassium follow, in about equal proportions, then hydrogen, provided that we include the ocean in our computations, and then titanium, amounting to about four tenths of one per cent. Manganese, phosphorus, sulphur, chlorine, fluorine and carbon are important; barium, strontium and zirconium are found in readily determinable proportions; vanadium, chromium and nickel are by no means negligible. The remaining elements, even including nitrogen, probably amount to less than one per cent., taken all together; a conclusion which is perhaps surprising, but is thoroughly well sustained. The heavy metals, with the sole exception of iron, are, in their total combined amount, statistically less important than titanium alone.

This statistical analysis of the igneous rocks has been verified by other workers, and its details are fully published elsewhere.[3] It was first made public in 1889, and it has since been largely extended and utilized as a basis for other computations. By combining the figures with those representing the known composition and mass of the ocean, it can be shown that a shell of the average igneous rock one third of a mile thick and completely enveloping the globe, would furnish all the sodium of the sea, and Professor Joly has gone even further and used these data as a measure of geological time.[4] Given values for the rate at which rivers supply salts to the ocean, and assuming that rate to have been constant, the calculation is a matter of simple arithmetic. If the salts of the ocean and the alkalies of the sedimentary rocks were all derived from the decomposition of igneous rocks, then a shell of the latter less than half a mile thick would yield all the sodium required. This estimate is a maximum, and serves to show how slightly the surface of the earth has been eroded during geological time. The greater part of this erosion, of course, was concentrated over the continental areas, being probably insignificant in the depths of the ocean. The land erosion may have been as much as two miles in thickness or four times the average for the entire globe. Going still farther, and using composite analyses of the sedimentary rocks, it can be shown that the half mile of decomposition has yielded determinable proportions of shales, sandstones and limestones. The approximate values for a ten-mile thickness of the earth's crust are, igneous rocks, 95 per cent.; shales, 4 per cent.; sandstones, 0.75 per cent.; limestones, 0.25 per cent.;[5]

[3] See especially U. S. Geol. Survey Bull. 330, pp. 21–33.

[4] *Sci. Trans. Roy. Soc. Dublin*, 2d ser., 7, 30, 1899.

[5] For other estimates, based upon the same fundamental data, see Van Hise, "Treatise on Metamorphism," p. 940; and Mead, *Journ. Geol.*, 15, 238.

figures which can not be very far out of the way. We have here a first approximation to an analysis of the entire crust of the earth, which can be applied to the discussion of various large geological problems.

Upon the basis of the survey analyses, Cross, Iddings, Pirsson and Washington developed their "Quantitative Classification of the Igneous Rocks,"[6] a classification which became possible only after a large number of complete analyses had been made, and which is applicable only to rocks which have been thoroughly analyzed. In this system, small errors become cumulative; and one effect of its publication has been to encourage better analytical work in several laboratories, and so to increase the accuracy of our knowledge relative to the composition and differentiation of rock magmas. It is interesting to note at this point that the average igneous rock is quite near an andesite in composition, and that it has very close to metasilicate ratios. From the last consideration it may be inferred that in the crust of the earth orthosilicates and trisilicates exist in approximately equivalent molecular proportions.

The chemists of the survey have also analyzed more than four hundred sedimentary rocks; slates, shales, sandstones, limestones, etc. They have also made composite analyses of many commingled samples in each sedimentary group, in order to determine the average composition of each class. The same method was also applied to the analysis of the well-known "red clay," which forms the floor of the ocean at its greatest depths. Fifty-one samples of the clay, kindly furnished by Sir John Murray, and gathered from all of the great oceans, were ground into one uniform sample and then analyzed. Even here the supposedly rarer elements were found in proportions similar to those of the igneous rocks, and such substances as titanium, barium, strontium, nickel, chromium, vanadium, copper, lead, zinc and arsenic were easily determined.

[6] University of Chicago Press, 1903.

Next in importance to the rock analyses are the analyses of minerals. Of these over 600 have been analyzed, covering more than 180 species, including eighteen which were described as new. The new species were josephinite, cuprobismutite, warrenite,[7] guitermannite, elpasolite, coronadite, zunyite, ptilolite, hydronephelite, lucasite, morencite, purpurite, antlerite, knoxvillite, redingtonite, plumbojarosite, emmonsite and powellite. Furthermore, the exact composition of many imperfectly described minerals has been well established, as in the cases of tengerite, kleinite, carnotite, roscoelite, patronite, xanthitane, hetærolite, mackintoshite and yttrialite. In Hillebrand's analyses of uraninite its gaseous constituent was first noted; and this gave Ramsay the clue which led to the discovery of helium. Molybdic ochre, previously assumed to be molybdic oxide, MoO_3, has been shown by Schaller, by the analysis of samples from five localities, to be a hydrous ferric molybdate. The true composition of dumortierite was also established by Schaller. The twenty complete analyses of tourmaline by R. B. Riggs and also his analyses of the lithia micas are important contributions to chemical mineralogy. The analyses of 29 meteorites can be added to this schedule.

Over 150 analyses of waters have been reported from the central laboratory of the survey. Some of these waters were from springs of commonplace type, but others have been of unusual character. One spring, from southwestern Missouri, according to Hillebrand's analysis, contains zinc sulphate as its principal saline con-

[7] According to L. J. Spencer warrenite is identical with jamesonite.

stituent, amounting to 233 parts per million out of 540 of total impurity. This water evidently rises from beds of zinc ores, and resembles the mine waters of the same region.

Forty-three waters from the Yellowstone National Park, analyzed by Gooch and Whitfield,[8] form a group of unusual interest. Among them are geyser waters, which deposit siliceous sinter and which contain in nearly all cases appreciable quantities of boric acid, lithia, arsenic and other unusual constituents. One hot spring in this group, the Devil's Inkpot, is unique. Its water is strongly acid, and contains 3.39 grams per kilogram of impurities. Of this impurity ammonium sulphate amounts to 2.82 grams, or more than 83 per cent. In addition to their study of the waters, Gooch and Whitfield analyzed many sinters, tufas, sediments and incrustations deposited by them, finding some substances of peculiar interest. One spring in particular was characterized by a deposit of scorodite, an arsenate of iron.

A second important group of waters is that represented by the saline and alkaline lakes of Nevada and southern California. Some of these waters are highly concentrated, and yield upon fractional evaporation large quantities of sodium carbonate. At Owens Lake, in California, sodium carbonate has been extracted on a commercial scale, and its production was carefully studied by Dr. T. M. Chatard.[9] The "natural soda" manufactured at Owens Lake was obtained in the form of trona or urao, a compound which Chatard studied thoroughly, and reproduced in the laboratory, thereby establishing its true composition beyond farther doubt. Chatard's memoir upon "natural soda" is a very complete summary of the entire subject.

Another remarkable water, that of Steamboat Springs, Nevada, was studied by Becker and Melville[10] in the San Francisco laboratory. This water contains notable quantities of borates, and it deposits a sinter carrying sulphides of arsenic, antimony, mercury, lead and copper, together with determinable amounts of gold and silver. Two other hot waters, from Sulphur Bank, California, also reported by Becker and Melville, were very rich in borates. At Steamboat Springs such minerals as metastibnite and cinnabar were caught in the very act of their formation. In connection with their study of these waters, Becker and Melville[11] made a series of experiments upon the solubility of various substances in solutions of alkaline sulphides and hydrosulphides. The sulphides of mercury, copper, zinc and iron (both pyrite and marcasite) were found to be, under suitable conditions of temperature and concentration, distinctly soluble; the sulphides of silver and lead were not. Metallic gold also dissolved perceptibly. These experiments shed much light upon the deposition of the metallic ores, and explain the peculiar composition of the sinter mentioned above.

Under the water resources branch of the survey a much larger hydrochemical investigation was undertaken. Under Mr. M. O. Leighton and Mr. R. B. Dole, with the aid of other chemists, the composition of many river and lake waters was determined, partly in a special laboratory in Washington, and partly in laboratories connected with other institutions in various parts of the United States. In all approximately 5,000 analyses were made of waters

[8] Bull. 47, U. S. Geol. Survey.

[9] Bull. 60, U. S. Geological Survey, pp. 27–101. The formula of trona, established by Chatard, is $Na_2CO_3 \cdot NaHCO_3 \cdot 2H_2O$.

[10] See G. F. Becker, U. S. Geological Survey Monograph 13.

[11] *Amer. Journ. Sci.* (3), 33, 199.

from about 180 lakes and rivers, representing the drainage from almost the entire surface of the country. To illustrate the plan of the work one example may be taken, that of the Mississippi just above New Orleans. A sample of water was taken daily, and at the end of each week the seven samples were combined and analyzed. This procedure was followed during a year, and the average of the 52 composite analyses thus made, gave the composition of the saline matter annually contributed from the entire drainage basin of the Mississippi to the Gulf of Mexico. In other cases ten-day composites were taken instead of weekly ones, and in some instances monthly analyses were made. These were combined with careful daily gaugings of the stream flow, so that the contribution of each river system to the ocean could be determined with a considerable degree of accuracy. A preliminary discussion of the data, which is subject to some small corrections yet to be investigated, leads to the conclusion that the surface of the United States loses to the ocean annually 87 tons of dissolved solids per square mile and 166 tons of suspended matter. This is equivalent to a lowering of the surface by aqueous denudation, one inch in 760 years. The usefulness of the investigation, however, is not limited to its geologic bearings; it is of direct value for industrial purposes, giving information as to the availability of the several waters for use in steam boilers, or in a variety of manufacturing processes. In its systematic character and its great extent the work is especially notable.

In the prosecution of their analytical work the chemists of the survey have not only been obliged to study existing methods, but also to devise new ones. The work of Hillebrand upon rock analysis has already been mentioned, but it does not stand alone. It was in the survey laboratory that Gooch developed his methods for determining boric acid and titanium, and for separating lithia from the other alkalies. Whitfield studied the indirect determination of chlorine, bromine and iodine; Chatard investigated the separation of titanium, chromium, aluminum, iron, barium and phosphorus; Hillebrand devised methods for the colorimetric estimation of chromium and the volumetric determination of vanadium. A comparison of the wet and crucible methods for the assay of telluride gold ores is due to the joint labors of Hillebrand and Allen;[12] and a process for the estimation of small quantities of fluorine in rock analyses was worked out by Steiger. All of this work, which I can only mention briefly, grew out of the necessities of the chemists in handling the analytical problems submitted to them by the geologists of the survey, and therefore had good reasons for its prosecution.

Apart from the routine analytical work of the laboratory, a variety of researches upon mineralogical and geochemical problems have been carried out. Some of the mineral analyses were made with direct reference to purely abstract investigations, such as the series of researches upon the constitution of the natural silicates; a problem which was commonly assumed to be hopelessly complex. The silicates, however, are not remarkably complicated substances, their complications being more apparent than real. The conditions under which they are formed, by deposition from molten magmas, or by alteration of such primary compounds, would seem to preclude any great complexity. Only relatively stable and therefore presumably simple compounds could exist; a conclusion which is borne out by their comparatively small number. The apparent complications are due to impurities, to alterations

[12] Bull. 253, U. S. Geol. Survey.

and to isomorphous mixtures; when these sources of doubt are eliminated, simple empirical formulæ can in most cases be deduced. To obtain such formulæ is obviously the first step in the general investigation; a task which, fortunately, had already been largely performed by others.

Empirical formulæ, however, do not solve the problem of constitution. That has to be attacked along other lines. The natural associations of the silicates, their isomorphous relations and their alterations all supply evidence, which can be supplemented by experiments in the laboratory. How does a mineral come into existence? How does it decompose? What characteristic reactions are possible with it? To each of these questions answers have been sought in the laboratories of the survey, and important data have been obtained. The synthetic work of Day and Allen on the feldspars was done in the Geological Survey, and similar researches are now being undertaken in the Carnegie Institution of Washington, to which that class of investigations has been transferred. The geophysical laboratory of the Carnegie Institution is a direct outgrowth from the survey, in which its work began.

The decomposition and alteration of silicates can be studied both in their natural occurrences and in the laboratory. When one mineral alters into another, a direct relation is established between the two, which the constitutional formulæ ought to symbolize. In the laboratory, such alterations may be often brought about artificially, as was done long ago by Lemberg and other investigators. The decomposition of minerals by heating is even more easily studied, and two or three reactions of this kind have been established in the survey. For example, talc, $H_2Mg_3Si_4O_{12}$, was commonly interpreted as an acid metasilicate, but Groth regarded it as a basic salt of metadisilicic acid, $H_2Si_2O_5$. In the latter case heating should of course eliminate water, but there could be no further breaking down. Clarke and Schneider, however, have shown that when talc is sharply ignited, one fourth of the silica is split off in the free state; a reaction which is intelligible only on the basis of a metasilicate formula. A similar reaction is furnished by pectolite, $HNaCa_2Si_3O_9$, which, as G. Steiger found, gives up one sixth of its silica upon ignition. In this instance, as in the case of talc, the liberated silica is proportional to the acid hydrogen in the initial substance. How far such reactions can be trusted in discriminating between metasilicates and the salts of other silicic acids is yet undetermined.

Similar experiments with serpentine gave even more important results. Daubrée had shown, qualitatively, that when serpentine is fused the residue is a mixture of enstatite and olivine. Olivine is easily soluble in dilute acids, enstatite is insoluble and it was therefore easy to ignite serpentine, to dissolve out the olivine, and so to prove that the reaction is quantitative. Now for its application. Tschermak had proposed a theory of the chloritic minerals, in which they were treated as mixtures of two end products, serpentine and amesite, the latter being an extremely basic salt to which the formula $H_4Mg_2Al_2SiO_9$ was assigned. If this were true, a chlorite like clinochlore should yield on ignition an insoluble residue containing the enstatite end of the serpentinous decomposition. In fact, a clinochlore which ought to have given 18 per cent. of enstatite gave none at all, but a residue consisting of spinel, $MgAl_2O_4$. That is, it failed to give the decomposition products of serpentine, therefore serpentine was absent, and the Tschermak theory fell to the ground. Other allied minerals furnished a similar spinel reaction, and in

each case the amount of spinel formed was quantitatively proportional to the excess of oxygen in the original silicate over the orthosilicate ratio. These reactions are, furthermore, applicable to the analysis of mixtures of talc and serpentine. It is only necessary to ignite the mixture, and then, with sodium carbonate to dissolve out the liberated silica of the talc, and with dilute hydrochloric acid the soluble olivine from the serpentine. Such an analysis is of course only approximate, but it is better than none at all.

In another group of experiments Clarke and Steiger[13] attacked the silicate problem by a different method. It was found that certain silicates when heated with dry ammonium chloride to its temperature of dissociation reacted with it, forming derivatives of unexpected stability. Analcite, $NaAlSi_2O_6 \cdot H_2O$, heated with the reagent in a sealed tube, yielded sodium chloride, and the silicate $NH_4AlSi_2O_6$, which was stable at 300°. Leucite, $KAlSi_2O_6$, similarly treated, gave the same derivative, thus establishing a structural relationship between the two species. By means of this reaction it became possible to determine, quantitatively, the proportion of either mineral in an igneous rock. The rock powder was heated with ammonium chloride, and then leached with water. The amount of ammonium fixed in the residue gave a good estimate of the amount of analcite or leucite in the rock. Natrolite gave with ammonium chloride another silicate, $(NH_4)_2Al_2Si_3O_{10}$, also quite stable, and other zeolites were capable of partial transformations. Going further, Mr. Steiger, by fusing the same minerals with silver nitrate or thallium nitrate, succeeded in substituting the alkaline bases by the two heavy metals, producing silver aluminum and thallium aluminum silicates identical in type with the original compounds and with the ammonium salts. These reactions are effected with great ease and open up a new line of attack upon the general problem of silicate constitution. In short, the silicates have been found to be chemically more plastic, that is, more open to measurable transformations than they were formerly supposed to be; a conclusion which is evidently of considerable theoretic importance. A new field of research has been opened, but its full extent is yet unknown.

[13] Bull. 207, U. S. Geological Survey.

From data such as these, and from the natural occurrences, associations and alterations of minerals, some progress has been made toward a theory of the silicates. At least, some relationships are now established, which can be rationally expressed by constitutional formulæ. Formulæ of that kind are easily written when one does not go beyond simple empirical composition, but unfortunately they can be written in several different ways. Each substance must be studied in its relations to other substances before a formula of real significance can be devised. When that is done a system of formulæ develops which becomes a useful tool in later investigations.

I can not, in a paper of this scope, enter into details. I can only give a brief indication of the theory which has grown out from the observed facts. First, the natural silicates are considered as definite salts, normal, acid or basic, of relatively simple silicic acids. Second, many silicates are easily interpreted as substitution derivatives of normal salts. For example, the normal orthosilicate of aluminum is represented by the formula $Al_4(SiO_4)_3$. This compound is not known to exist by itself in nature, but many minerals are easily interpreted, at least stoichiometrically, as derivatives of it. Thus we have

Nephelite,	$Al_3(SiO_4)_3Na_3$.
Eucryptite,	$Al_3(SiO_4)_3Li_3$.
Kaliophilite,	$Al_3(SiO_4)_3K_3$.
Andalusite,	$Al_3(SiO_4)_3(AlO)_3$.
Topaz,	$Al_3(SiO_4)_3(AlF_2)_3$.

All of these formulæ are equivalent to the simplest empirical formulæ tripled; a multiplication which is suggested by the fact that all of the minerals named alter into muscovite, $Al_3(SiO_4)_3KH_2$. This species in turn is correlated with the other normal micas, as follows:

Muscovite,	$Al_3(SiO_4)_3KH_2$.
Biotite,	$Al_2(SiO_4)_3Mg_2KH$.
Phlogopite,	$Al(SiO_4)_3Mg_3KH_2$.

Between these micas there are intermediate mixtures, and sometimes admixtures of molecules derived in precisely the same way from trisilicic acid, $H_4Si_3O_8$. That is, the radicles SiO_4 and Si_3O_8 replace each other isomorphously, a relation which is also indicated in the feldspar group. Albite is a trisilicate, anorthite is an orthosilicate; the other soda lime feldspars are mixtures of these two.

This formulation of the micas has had considerable acceptance, and it brings the allied compounds under one general set of expressions. These again connect with the vermiculites and chlorites, and with a number of other species such as the garnets, prehnite, some zeolites, etc. In short, a system of formulæ has developed from work done in the survey laboratory which expresses in symbolic form known relations, and is therefore legitimate so far as it goes.[14] It is probably not final, but its usefulness is apparent and has been tested for many years. When a better system offers, one which correlates a larger number of facts, it will be time to abandon this and to accept the new.

Another group of researches, now under way in the survey laboratory, relates to the theory of ore deposition. It had been observed by geologists connected with the survey that ore deposits often exhibit the phenomenon of secondary enrichment; that is, the heavier metals are more or less dissolved from the upper part of a lode, to be reprecipitated at lower levels. The chemical processes governing this leaching and redeposition are among the subjects under investigation in the laboratory. This problem, obviously, interlaces with other related problems, and some interesting results have already been obtained. Dr. H. N. Stokes has studied the relations between pyrite and marcasite,[15] and in another investigation[16] he has determined some of the conditions governing the solution, transportation and deposition of silver, copper and gold. The details of these experiments do not admit of any brief summary here. Dr. E. C. Sullivan[17] has shown that many secondary precipitations of the heavy metals are of the nature of double decompositions; a copper solution, for example, reacting with silicates such as the feldspars to give up its copper and to receive some other base in return. He has also found[18] that the wall rock of a vein may act like a semi-permeable membrane and so effect the separation of certain bases from their salts. A solution of ferric sulphate, for instance, hydrolyzes, and then contains ferric hydroxide in the colloidal condition. When this operation takes place in a Pasteur filter tube the colloidal substance is retained, while the liberated acid passes through. In short, dialysis seems to be one of the processes by which mineral solutions are separated into fractions of different composi-

[14] See U. S. Geol. Survey Bulletin 125 for a complete statement of the silicate theory. Some of the conclusions reached in that memoir need to be revised in the light of more recent knowledge.

[15] Bull. 186, U. S. Geol. Survey; and *Economic Geology*, 2, 15.

[16] *Economic Geology*, 1, 644.

[17] Bull. 312, U. S. Geol. Survey.

[18] *Economic Geology*, 3, 750.

tion; a process which has an important influence in the filling of metalliferous veins. Researches of this class are being continued, and should lead in time to useful conclusions.

One research, outside of the normal work of the survey, was carried out by Dr. H. N. Stokes in the survey laboratory. I refer to his remarkable investigation of nitrogen chlorophosphide.[19] From this supposedly well-known compound, $P_3N_3Cl_6$, Dr. Stokes developed a series of polymeric bodies, $P_4N_4Cl_8$, $P_5N_5Cl_{10}$, $P_6N_6Cl_{12}$ and $P_7N_7Cl_{14}$. Each of these yielded its own characteristic phosphimic acids, and other derivatives, and thus a new field of study in inorganic chemistry has been opened, which deserves to be carefully cultivated in the future.

From what has been said so far it is clear that the chemical work of the Geological Survey is not limited by utilitarian considerations, but is also distinctly scientific in its aims. It was felt that the investigations of the geologists could be aided fully as much by chemical researches as by mere routine analyses, and the results obtained seem to justify this supposition. As a further help to geology, the more important data of geochemistry have recently been brought together in the form of a large bulletin,[20] in which the carefully verified bibliographic references are quite as useful as the text. Furthermore, the chemical work has been carried on in close relations with various physical researches, among which the studies by Carl Barus of the iron carburets, the thermoelectric measurement of high temperatures, and the behavior of fused rocks as electrolytes are conspicuous. At present, under G. F. Becker, the subject of elasticity is being investigated, with reference to some of the larger problems of geophysics. Physics and chemistry are in contact at so many points that applications of the one inevitably compel consideration of the other.

There is, however, a natural call for data of immediate economic significance; and to meet this demand some special laboratories have been recently organized. In 1904, at the St. Louis Exposition, the Geological Survey established a coal-testing plant, in which a great number of coals were studied from various technical points of view. From this enterprise the technologic branch of the survey was developed and in it a variety of chemical investigations are now being conducted. Coals, including lignites and also peat, are collected and sampled in large lots, and analyzed both proximately and ultimately. Their calorific value is directly measured, their availability for briquetting or for the manufacture of producer gas is studied, and certain problems which arise in mining operations are also taken into account. For instance, the gases evolved from coal within the mine are carefully examined, and the explosives used by the miners are investigated also. At present the prevention of mine explosions is receiving special attention; and one laboratory is devoted to that subject alone. In another laboratory the proximate constituents of coal are being isolated, with a view to ascertaining their true character. Work of this kind is evidently capable of indefinite extension, and how far it may ultimately go it is impossible to foretell.

Another group of investigations, which is partly chemical, relates to the manufacture and properties of cement, and its use as a structural material. Clays, limestones and finished cements are subjected to analysis, and the question of their durability under special conditions is also studied. The government of the United States is engaged in the reclamation of great areas of arid lands, and is constructing large

[19] Bull. 167, U. S. Geol. Survey, p. 77.

[20] "The Data of Geochemistry," by F. W. Clarke. Bull. 330 of the U. S. Geological Survey, 1908.

reservoirs and dams to impound water for purposes of irrigation. These waters are often strongly alkaline, and affect the concrete of the dams most injuriously. To avoid this evil is one of the important problems now in hand.

One laboratory of the technologic branch is in Washington, and its particular function is to examine the coal purchased for the use of the government, and also to pass upon the quality of the structural materials used in public works. This latter heading covers not only substances like cement, plaster, clay, brick and terra cotta, but also iron and steel, mineral paints, and roofing materials, whether of metal or of asphalt. In short, this laboratory is entirely technologic in character, and its chemists find their time fully occupied with routine affairs.

Although petroleum is studied by the technologic branch with reference to its efficiency as fuel; still other investigations upon it are carried on in a distinct laboratory under Dr. David T. Day. Dr. Day is engaged upon a systematic study of all the petroleum fields of the United States, determining the physical properties of the oils and examining their distillation products. In each oil he determines sulphur, asphaltum, paraffin, water and the unsaturated hydrocarbons, and when this preliminary investigation is finished the work will be further developed with regard to special details. It is proposed also to reexamine the oils from time to time, in order to ascertain whether the wells have undergone any change in character. In this work Dr. Day cooperates with a committee of the International Congress on Petroleum, for the purpose of establishing uniform and trustworthy methods of research. Dr. Day has also, for several years, been studying the filtration of petroleum through clays and shales, in which he finds that a fractionation is effected similar to that produced by distillation. This work is being continued, and is yielding interesting results.

F. W. Clarke

U. S. Geological Survey

THE POPULATION OF FRANCE

In view of the interest in the thirteenth census of the United States for 1910, of which the law governing the enumeration has just been passed, the readers of Science may be interested in the report of the chief of general statistics of the movement of population in France, during the year 1908, as given in the *Journal Officiel.* This is all the more interesting because of the views entertained in some quarters that France should be numbered among the so-called decadent peoples. The figures for 1908, however, show that the excess of births over deaths, based upon an enumeration of 315,928 marriages, amounts to 46,441. The corresponding figure for the ten years ending with 1907 was 40,550. The following table gives the comparative returns for the decade, with which 1908 is compared:

Years	Marriages	Births	Deaths	Excess of Births	Excess of Deaths
1898	287,179	843,933	810,073	23,860	....
1899	295,752	847,627	816,233	31,394	....
1900	299,084	827,297	853,285	....	25,988
1901	303,469	857,274	784,876	72,398	....
1902	294,786	845,378	761,434	83,944	....
1903	:95,996	826,712	753,606	73,106	....
1904	298,721	818,229	761,203	57,026	....
1905	302,623	807,291	770,171	37,120	....
1906	306,487	806,847	780,196	26,651	....
1907	314,756	773,645	793,537	....	19,892
Av. 1898-1907	299,885	825,423	788,461	40,550	4,588
1908	315,928	791,712	745,271	46,441	....

It is noteworthy that for 1908 the number of deaths was the smallest in eleven years and considerably smaller, of course, than the average for ten preceding years. In births there is a recovery from the minimum of 1907, and marriages are the largest in eleven years, being five per cent. greater than the

average for 1898–1907. These are the facts, whatever the explanation may be.

JOHN FRANKLIN CROWELL

NATIONAL INSPECTION TO PREVENT IMPORTATION OF DESTRUCTIVE INSECTS

DR. L. O. HOWARD, chief of the Bureau of Entomology of the U. S. Department of Agriculture, has returned to Washington from Europe, where he has been engaged during the past month in interviewing paid and volunteer agents of the Department of Agriculture and the state of Massachusetts who are assisting in the importation into the United States of the parasites and other natural enemies of the gipsy moth and brown-tail moth. In the course of this work, according to a bulletin of the U. S. Department of Agriculture, Doctor Howard visited France, Holland, Germany, Russia, Austria, Hungary, Switzerland and England, and the results of the trip are already evidenced by the receipt at the parasite laboratory, Melrose Highlands, Mass., of a greatly increased amount of parasitized material, which is being handled at that point by expert assistants and will subsequently be liberated in woodlands ravaged by the gipsy and brown-tail moths. A great interest is shown in the different European countries in this very large-scale experimental work, and the official entomologists and others are anxious to do everything in their power to help the United States.

The brown-tail moth, it will be remembered, was accidentally introduced into this country upon plants imported from Europe. Many other injurious insects have been brought in in the same way, and the danger still exists in the absence of any national quarantine and inspection law. Such quarantine and inspection laws are in force in nearly all civilized countries of the world, and the United States is almost unique in its indifference to this great danger. The amount of money that has been spent by the different states in New England and by the general government in fighting the gipsy and the brown-tail moths alone would support a national inspection service for many years. Last winter there were brought into the United States, mainly at the port of New York, thousands of apple and pear seedlings from France which carried the winter nests of the brown-tail moth. These seedlings were distributed all over the country. An effort was made, through the assistance of the custom-house authorities and the railroads, to trace of all these shipments to their destination and to secure inspection and destruction of the injurious insects before the opening of spring. It is probable that these efforts were successful, but the experience emphasizes the necessity for a national law.

Doctor Howard was instructed by Secretary Wilson to visit the leading exporting nurseries in Holland, France and England in order to determine the efficiency of any inspection service that might exist in those countries. He found that the inspection service in Holland is excellent, as conducted by J. Ritsema Bos, of Wageningen, and his assistants. Nursery stock bearing the inspection certificate of these officials can be accepted in this country without any danger.

In France it was found that no governmental inspection service exists and that the certificates which have hitherto accompanied nursery stock from that country can not be relied upon. After consultation with the leading nurserymen and the authorities of the Ministry of Agriculture of France, Doctor Howard was assured by the Director of Agriculture, M. Vassillière, that the French government will immediately establish an official inspection service, under the direction of Dr. Paul Marchal, a thoroughly competent man well known for his work on injurious insects, so that in the future nursery stock coming from France and bearing the inspection certificate of the Ministry of Agriculture can be relied upon.

In England, it was found that no governmental inspection service for home nurseries exists. Officials of the Board of Agriculture assured Doctor Howard that it is the desire of the board to establish such a service, but that the demand must come from the English nurserymen. Members of the Council of the National Association of Nurserymen, of England, were then interviewed, and it seems

reasonably certain that this influential organization will request the Board of Agriculture to establish such a service under the direction of some competent entomologist like Mr. Cecil Warburton, at Cambridge, or Mr. F. V. Theobald, of Wye.

THE FIVE HUNDREDTH ANNIVERSARY OF THE UNIVERSITY OF LEIPZIG

THE committee which took up the task of preparing a suitable memorial address to the University of Leipzig at its five hundredth anniversary has completed its work far enough to send through Professor Williston Walker an illuminated address. This was done in illuminated Caxton letters which belong to the period of the establishment of the university, on three sheets of vellum. The whole was bound in a case of dark green crushed levant lined with white silk. The address which appeared on the first page was as follows:

Almæ Matris Lipsiensis Alumni quondam Americani Rectori Magnificentissimo Illustrique Senatui Inclitæ Universitatis Lipsiensis S.D.P.

Iucundum profecto et honorificum nobis accidit quod participes esse possumus lætitiæ Vestræ et interesse sacris sæcularibus quibus natalem quingentesimum celebratura est inclita Universitas Lipsiensis, et optimarum artium studiorumque severorum cultrix et iuvenum erecta indole ad veræ laudis palmam tendentium fida magistra. Et enim fieri non potest quin memores simus eorum qui semina sapientiæ severint quæ insequentibus sæculis prosint, sic non minore laude ei digni videntur esse qui quæ a maioribus acceperunt diligenter tutati auxerunt.

Nos autem, quamvis alieno sub cælo nati simus, haud alieni hic venimus, immo domum redire videmur, quibus et magistri et doctores, quin etiam locus ipse mutus hic ubi liberalibus artibus imbuti et docti simus cum grata recordatione in mente versetur. Quæ cum ita sint, non tam officio quam pietate adducimur ut meritam Almæ Matri Lipsiensi gratiam iustis honoribus et memori mente persolvamus, Deumque Optimum Maximum comprecamur ut ductam a maximis laboribus plurimaque virtute stabilitatam Musarum huius sedis gloriam servet et sospitet.

On this first page the capital "I" and the capital "N" at the beginnings of the two paragraphs were elaborately illuminated initials with borders extending upward and downward, enclosing the rest of the matter on the page.

On the second and third pages were the names of the doctors from Leipzig done in Roman capitals, preceded by a brief introduction of the delegate. These pages were also decorated with a border and illumination of the first initials. Photographs of the various pages of the address can be obtained by writing to A. B. Corbin, Chapel Street, New Haven, Conn.

In addition to this memorial a fund of about $350 is being utilized in sending to the library certain back numbers of American scholarly journals for which the library made special request to the committee, and also in presenting to the library subscriptions to a number of American scholarly journals which the library mentioned in its correspondence with the committee as omitted in the regular list.

The Smithsonian Institution has generously consented to allow the use of its International Exchange service for the shipment of all of this material, so that the journals can be obtained at the regular American rate and back numbers can be forwarded without expense other than that necessary to take them to Washington.

The committee has acknowledged personally to each of the subscribers the receipt of checks and other remittances. If any member of the association cares for a detailed account of the shipments to the library this can be secured by writing to the secretary.

The committee consisted of: Professor J. McK. Cattell, of Columbia University; Professor E. B. Titchener, of Cornell University; Professor Hugo Münsterberg, of Harvard University; Dr. Cushing, principal of the New Haven High School, New Haven, Conn.; Professor Williston Walker, who acted as the delegate and took the memorial to Leipzig; and the secretary.

CHARLES H. JUDD,
Secretary

SCIENTIFIC NOTES AND NEWS

As has already been announced, the presidential address at the Winnipeg meeting of the British Association will be given by Pro-

fessor J. J. Thomson, of Cambridge. The addresses before the sections will be given by the presidents as follows: Mathematical and Physical Science—Professor E. Rutherford; Chemistry—Professor H. E. Armstrong; Geology—Dr. H. Smith Woodward; Zoology—Dr. A. E. Shipley; Geography—Sir Duncan Johnston; Economic Science and Statistics—Professor S. J. Chapman; Engineering—Sir W. H. White; Anthropology—Professor J. L. Myres; Physiology—Professor E. H. Starling; Botany—Lieutenant-Colonel D. Prain; Educational Science—Dr. A. P. Gray.

The seventh annual meeting of the South African Association for the Advancement of Science will be held at Bloemfontein during the week ending on Saturday, October 2, under the presidency of Sir H. Goold Adams.

The Swiss Society of Natural Sciences holds its ninety-second annual meeting this year at Lausanne from the fifth to the eighth of September, under the presidency of Dr. H. Blanc. Among the public addresses are "The Jura," by M. Emmanuel de Majorie; "The Aerodynamic Basis of Aeronautics," by Dr. Bastien Finsterwalder, and "Comparative Psychology," by Professor August Forel.

The eleventh International Geological Congress will open at Stockholm about the eighteenth of August, 1910. Professor G. De Geer, of the University of Stockholm, is president of the executive committee. The secretary from whom information may be obtained is Professor J. V. Andersson, director of the Swedish Geological Survey.

Mr. Henry Balfour, curator of the Pitt and Rivers Museum at Oxford, made the presidential address at the twentieth annual conference of the Museums Association which opened at Maidstone, on July 13. Mr. E. Haworth has resigned the secretaryship of the association and the editorship of the *Museums Journal*. Mr. E. E. Rowe succeeds him as secretary and Mr. F. R. Rowlee as editor.

The Association of Economic Biologists met at Oxford from July 13 to 15, under the presidency of Dr. E. A. Shipley.

Professor W. K. Hatt, of Purdue University, will represent the Forest Service at the Congress of the International Association for Testing Materials at Copenhagen, September 7 to 11, and will also report on certain problems in Wood Preservation in Germany.

Dr. A. W. Morrill, in charge of Citrus white-fly investigations of the Bureau of Entomology, U. S. Department of Agriculture, has accepted the position of entomologist of the Arizona Horticultural Commission and of the Arizona Experiment Station.

A portrait of Professor W. Stroud (who, after twenty-four years' service in the chair of physics at Leeds, has resigned the post on his removal to Glasgow), has been presented to the University of Leeds. The portrait, which has been painted by Mr. W. Llewellyn, of London, is the gift of friends and past students.

Dr. Karl Runge, of Göttingen, Kaiser Wilhelm professor at Columbia University next year, will give an extended course, "Graphical Methods in Physics and Applied Mathematics."

Mr. Percy Wilson, administrative assistant in the New York Botanical Garden, has returned from the Bahamas after a survey of the islands of the Salt Key Bank. Mr. W. W. Eggleston has completed a four weeks' collecting trip in the Cumberland-Tennessee River region of western Kentucky.

It is reported in *Nature* that the committee nominated by the Paris Academy of Sciences for the distribution of the Bonaparte fund (25,000 francs) for 1909 has received thirty-five applications, only nine of which are considered to conform with the regulations laid down by the committee of 1908. It is proposed to allocate the fund as follows: 4,000 francs to M. Cayeux, to enable him to pursue his researches on the fossils of the Oolitic iron deposits in the United States; 4,000 francs to M. Chevalier, to assist him in carrying on his geographical and ethnographical researches in the French colonies in tropical Africa; 4,000 francs to M. Pérez, to assist in the publication of his memoir entitled "Recherches histologiques sur les Métamorphoses des Mus-

cides"; 3,000 francs to M. Houard, to enable him to proceed to Corsica, Algeria and Tunis, to collect material for his anatomical and physiological studies; 2,000 francs to M. Berget, for the construction of an apparatus for the study of the distribution and intensity of gravity; 2,000 francs to M. Bernard, to continue his studies of the variation of the solar radiation and the illumination of the sky in the immediate neighborhood of the sun; 2,000 francs to M. Blaringhem, for the continuation of his experimental researches on the variation of species; 2,000 francs to M. Estanave, for the continuation of his researches on stereoscopic projection by direct vision, stereoradiography and autostereoscopy; 2,000 francs to M. Mathias, to enable him to continue in the cryogenic laboratory of Leyden his researches on liquids and on the law of corresponding states at low temperatures.

THE death is announced of Mrs. Jane L. Gray, the widow of Asa Gray, who since her husband's death, has lived in the curator's house of the Harvard Botanical Garden.

DR. WILLIAM HUNTER, government bacteriologist in Hong Kong, known for his valuable studies on the diseases of the Chinese, died on June 9, at the age of twenty-four years.

DR. A. HERZOG, professor of mechanics at the Zurich Polytechnicum, has died at the age of fifty-seven years.

THE death is also announced of M. Henri de Parville, an engineer, but known as a writer on popular science and formerly as the editor of *La Nature*.

SIR FRANCIS GALTON has made a further donation of £500 to the maintenance of the Laboratory for National Eugenics under the direction of Professor Karl Pearson, of the University of London.

A NUMBER of public bequests are made by the will of Miss Emma Sarah Wolfe, including £1,000 each to the Royal Anthropological Institute, the Royal Geographical Society and the Royal Archeological Society.

MR. ANDREW CARNEGIE has made an additional gift of £19,000 to Liverpool for two branch libraries.

THE sixth annual meeting of the American Breeders' Association is called for December 8, 9 and 10, at Omaha, Nebraska, in association with the National Corn Show held at that place December 6 to 18. A program of addresses by breeders of livestock, breeders of plants and scientific men engaged in the study of the heredity of plants, animals and men is being prepared. Arrangements are being made to have many of the addresses illustrated with stereopticon views and moving pictures.

A MEETING of the Italian Congress of the History of Medicine and Natural Science will be held at Venice towards the end of September.

WE learn from the *British Medical Journal* that the fourth series of lectures on scientific microscopy at the Institute for Microscopy of the Jena University, will be held from October 11 to 16. In addition to the lectures, practical demonstrations will be given on the Abbé refraction apparatus test plate and apertometer, and on photomicrography with ultra-violet light, with monochromatic visible light and with incident light (for metallography), and on ultramicroscopy of firm colloids of colloidal solutions and of the cells and fibers. Further particulars can be obtained from Dr. Ehlers, Beethovenstrasse 14, Jena. The first of these courses was held in Jena in 1907, the second in Vienna in 1908 and the third in Berlin in March last. The fifth course will be given at Leipzig in March, 1910.

THE movement of the population of the German Empire is now for the first time, with the figures for 1907, made the subject of a separate volume in the publications of the Imperial Statistical Office. According to an abstract in the London *Times* there is a marked decline in the birth rate, which fell to 33.2 per 1,000 inhabitants, as compared with 34.08 in 1906. The death rate fell to 18.98 as compared with 19.20 in 1906. The excess of births over deaths was 882,624 as compared with 910,275 in 1906. The excess, however, of births over deaths (natural in-

crease of population) was greater in 1907 than in any previous year except 1906 and 1902 (902,243). The decline in the birth-rate, which stood at 41.64 in 1877, 38.33 in 1887 and 37.17 in 1897, as compared with 33.2 in 1907, is now attributable to a falling off in the number of births in every part of the empire except Westphalia, and in Westphalia the number of births is not quite keeping pace with the total growth of population. The decrease in number of births in the whole empire in 1907 was 23,766 or 1.1 per cent. In Saxony the decrease was 3 per cent., and East Prussia, West Prussia and Pomerania show about the same percentage. As regards the death-rate, which stood at 28.05 in 1877, 25.62 in 1887 and 22.52 in 1897, as compared with 18.98 in 1907, there is a steady decline in the infant mortality rate in all parts of the empire, but especially in large towns.

ALL the Alaskan field parties of the Geological Survey are now at work or on their way to the interior. The surveys and investigations of 1909 include fourteen parties, which are widely distributed over Alaska. These parties comprise twelve geologists, seven topographers and three engineers. Two parties will be at work in southeastern Alaska, one in the Copper River region, two in the Matanuska coal region, one in the eastern part of the Kenai Peninsula, two in the Iliamna Lake region, two in the Yukon-Tanana region, one in the Koyukuk and Chandalar districts, one in the Norton Bay region, and one in Seward Peninsula. These surveys and investigations are carried on under the direction of Alfred H. Brooks, who left Seattle for Cordova on the first of July. From Cordova he will proceed up Copper River and make a brief visit to the Nizina district. Circumstances permitting, he will then go by overland trail to Fairbanks and later will pay a visit to the Berners Bay and Eagle River districts, in southeastern Alaska.

How long will timber remain commercially valuable after it has been swept over by a forest fire? Timber land owners as well as the federal government are much interested in obtaining this information, and the government has just begun an investigation of a large number of fire areas in Oregon and Washington in order to determine, if possible, the length of time which will elapse after a forest fire before the timber deteriorates to such a condition as to decrease its commercial value. The agencies which cause timber to decay and encourage the attack of wood borers are undoubtedly influenced to a greater or less degree by the intensity of the original fire and the climatic conditions and altitude of the burned areas. All the information in connection with this investigation will be obtained first hand by the Forest Service, either from government timber land, or from private holdings where logging operations are under way. In this connection the Forest Service has also undertaken an investigation to determine the relative strength of green and fire-killed timber. The material which is to be tested is being sawed at the mill of the Eastern and Western Lumber Company of Portland, Oregon, where it will be surfaced to exact sizes and then transported to Seattle, where tests will be made in connection with the Forest Service exhibit at the exposition. The fire-killed trees which are to yield material for these tests were selected by representatives of the Forest Service on the holdings of the Clarke County Timber Company of Portland, Oregon, near Yacolt, Washington. This timber was burned over seven years ago and represents fairly well the average of burned timber found in the Pacific northwest. The logs which vary from three to four feet in diameter, were sawed into thirty-two foot lengths. These are being manufactured into sixteen-foot floor joists and bridge stringers. The results of these tests are expected to disapprove the opinion generally held regarding the strength of fire-killed timber.

Tropical Life announces a prize of fifty pounds sterling for an essay embodying research work directed towards ascertaining exactly what changes (together with their causes and whether these changes occur during the fermentation process only or while being dried) take place in the cacao bean between the time that it leaves the pod until it is

shoveled into the bag for export. For further information those interested may address the editor of *Tropical Life*, 112 Fenchurch street, E. C. London.

UNIVERSITY AND EDUCATIONAL NEWS

The College of Agriculture of the University of the Philippines, situated at Los Banos, opened on June 14, with about sixty students. E. B. Copeland is dean and professor in botany; Harold Cuzner, professor of agronomy; Edgar M. Ledyard, professor of zoology, and S. B. Durham, professor of animal husbandry. The university opened a school of fine arts in Manila at the same time; it has no entrance requirements, and its registration is above 400. A college of veterinary science, for high school graduates was announced to open at the same time but there was only one applicant for admission. The secretary of public instruction, Judge Newton W. Gilbert, is acting president of the university.

Professor K. E. Guthe, of the University of Iowa, has accepted a call as professor of physics to the University of Michigan.

Dr. Burton E. Livingston, staff member, Department of Botanical Research of the Carnegie Institution of Washington, has accepted an appointment as professor of plant physiology in the Johns Hopkins University. He will assume his new duties with the opening of the next academic year.

It is stated in the daily papers that Professor W. J. V. Osterhout, of the department of botany of the University of California, has accepted a call to Harvard University.

Mr. William T. Horne has resigned his position as plant pathologist of the Cuban Agricultural Experiment Station to become assistant professor of plant pathology in the University of California.

Mrs. Ella Flagg Young, principal of the Chicago Normal School since 1905 and previously professor of education in the University of Chicago, has been elected superintendent of Chicago's public school system.

Joseph S. Chamberlain, Ph.D. (Johns Hopkins), chief of the laboratory of Cattle Food and Grain Investigations of the Bureau of Chemistry, U. S. Department of Agriculture, has been appointed associate professor of chemistry in the Massachusetts Agricultural College.

Mr. A. G. Christie, formerly in the steam-turbine departments of the Westinghouse and Allis-Chalmers companies, has been appointed assistant professor of steam engineering at the University of Wisconsin.

Professor L. P. Dickinson, of the electrical engineering department of Lafayette College, has been appointed professor of electrical engineering at Rhode Island State College to succeed Professor Gilbert Tolman, who recently resigned to accept a chair at Colby College.

Dr. Robert F. Sheehan has been appointed professor of hygiene at the University of Buffalo to succeed Dr. Henry R. Hopkins, who has been appointed emeritus professor of hygiene. Dr. Herbert Hill has resigned as professor of chemistry, toxicology and physics.

DISCUSSION AND CORRESPONDENCE

THE DUTY OF PUBLISHING

The reason for all scientific investigation, that which not only justifies but even demands it, is the help its results, when known, will be to the human race through the fuller knowledge men will then have of the laws of the universe in which they are placed and from which they can not escape.

From this it follows that no investigation need be made—the labor and the expense of it are to no purpose—unless the results are to be published, that is, brought to the attention of those, preferably as many as possible, who are most likely to use this information in a manner helpful to themselves and to the rest of the world.

How much better it would have been if Willard Gibbs, for instance, instead of printing accounts of his investigations in a journal of most limited circulation, had published where the whole scientific world could have seen them. For nearly a generation his remarkable discoveries were of no honor either to himself or to the institution with which he

was connected, nor of any help to the progress of science. During all this time they remained hidden in that obscurity to which they at first had been consigned, and from which they were rescued only after many of them had been rediscovered and properly published.

Another case of inadequate publication, and there have been many similar ones, is the first account of a method for detecting optically the presence of objects beyond the highest power of the microscope, as ordinarily used. This appeared in a weekly engineering journal which biologists, and others interested in high-power microscopy, probably rarely saw and never read. Mr. Dubern had as well never made his important discovery. For more than twenty years the world knew nothing of it, and even then not until, and because, some one else had rediscovered and really published the same method.

There is a piece of biblical wisdom that warns against casting pearls where they will receive but scant attention, and the same thing applies to the printing of papers where they don't belong. A paper out of place is a paper unpublished, no matter how many may see it. But unwise as it may be to send an article to an inappropriate journal, it is just as useless to give it to one that is without circulation. No scholar, however able, can reasonably expect to do much good who confines the accounts of his discoveries to the "Transactions of the Village Academy," or to the "Publications of the Humdrum Laboratory"—publications, both of them, for which there is neither room nor proper reason. No room, because not even libraries, much less individuals, can handle that unnecessary and unworthy mass of pamphlets of which these are ideally typical; nor proper reason, since commonly the existing journals are capable of publishing all that is worth printing.

It is true that once in a while there is a real necessity for a new journal, but it should not be started till the need for it is urgent, for the cost of taking and the burden of handling them is already beyond the means and the ability of the private scholar, and fast becoming a serious tax on even large libraries. A new journal unnecessarily added is nothing short of an unwarranted imposition, and it deserves to be treated as such. But for all that, there are many of just this kind. They exist because of that foolish pride that puffs itself up in a vain effort to imitate the ox; or else, and often, because of the abominable necessity for political buncombe. In either case one article is quite as good as another, and about as likely to be printed, provided only that it is lengthy, learnedly muddled and handsomely illustrated. These, of all others, are to be avoided in every way possible. To print in them is not to publish, for they are neither shelved by libraries nor read of scholars.

When an investigation has but a single interest, astronomical for instance, it is sufficient and proper for it to appear in but one journal, some astronomical one in this case, of wide circulation. When, however, its interests are distinctly twofold then the purpose of the investigation—the spread of helpful knowledge—is best met by publishing it in an appropriate journal of each of the sciences which it concerns. To do less than this is for the investigator to neglect his duty, to hide his light under a bushel, which is just as reprehensible in the scientific as it is in the moral world. To him that discovers let honor be given, for he is a genius; but to him that discovers and publishes let there be given double honor, for he is a genius that has done unto others as he would have others do unto him.

The necessity of treating a scientific question one way for one purpose, and another for a different purpose, has led to several legitimate classes of journals and publications. Those of a semipopular type, of which SCIENCE and *Nature* are good examples, are especially adapted to addresses before scientific societies, book reviews, notes and brief articles of general interest. In a sense these are what might be called the scientist's newspapers, delightful and valuable to every scholar, no matter what his specialty.

Distinctly different from these, though like them in the sense that their pages are open to

any one who has the proper material to contribute, are the technical journals, whose contents generally are concisely written and therefore, while of the highest value, commonly intelligible to only a limited class of specially trained readers. They form the library, for which any one can subscribe, of the creative scholar, to which he turns for the most exact and for the most accessible information on every subject in which he is interested. It is here that the scientist is expected to publish in condensed form, for the use of his fellow specialists, his every discovery, the methods and the results of his every investigation; and that too as soon as possible.

Entirely different from either of the foregoing types, and for a different purpose, are the annals, year books, bulletins and other publications of observatories, societies, government bureaus and departments. Here the pages are seldom open save to those officially connected with the particular institution, society or bureau specifically represented. In most cases they appear irregularly at long intervals and are restricted in circulation practically to a limited free distribution. They are for the purpose of preserving for reference in extended form, with all helpful minutiæ, those investigations of the particular observatory or bureau concerned which, because of their length or their diffuseness, are not adapted to the technical press.

For the sake, therefore, of reaching a larger number of interested readers, and often, too, for the sake of an earlier publication, it is desirable to send to the technical journals many articles that are expected to appear in a more extended, or even in substantially the same, form in official bulletins and annals. And this is all the more important in the case of those articles that also concern some science in addition to the one commonly dealt with in the bulletins or annals in which they appear.

The scientific public expects that whatever one may print officially he will, as soon as possible, come out in the open with what he believes to be contributions to knowledge, and submit them where they will be accepted or rejected according to their merits; and where if accepted they will be read and subject to criticism. This is publishing in the true sense of the term, and is incumbent upon every investigator. Confining an article to an official bulletin, however excellent and necessary it may be, often amounts to but little more than mere printing for private distribution, because scholars do not and will not wade through tedious bulletins and annals for that which they expect to find in a more condensed form in more accessible journals.

When, for official reasons, the author is not free to do as he chooses, publication of any kind must have the sanction of the proper authority. Commonly, however, those in authority are glad to grant this privilege to any one capable of writing a paper acceptable to the technical press. In fact they often urge it upon him for the sake of those who can profit by such articles, and incidentally for the well-deserved encouragement of the authors themselves, and for the credit their work will bring to the institutions with which they are connected. They realize that it is an honor to any man to have his papers accepted by a discriminating scientific journal, and that the reputation of any institution is that of its work that is known and no more.

Every scientific question should be investigated carefully, honestly, thoroughly; the results published quickly, openly, fully.

To discover is the scientist's reward, to publish is his duty.

W. J. Humphreys

REFLEX ACTION AFTER DEATH

On the afternoon of April 27, 1909, while returning from the day's work on precise leveling, over the Santa Fe Railroad, to Goffs, California, the velocipede car on which I was riding passed over a rattlesnake, which was lying between the rails. It rattled, and I stopped the car and went back to investigate. It was what is locally known as the "sidewinder," by which I understand it to be the horned rattlesnake, or *Crotalus cerastes*. It was lying stretched to nearly its full length, and rattled again, without coiling. Taking a

spud-bar (an iron implement shaped like a crow-bar, with a chisel-blade at one end, for digging) with one blow I cut its head squarely off. The body was taken back to camp. This was about 5 P.M.

About eight o'clock that evening, wishing to skin the snake, I placed the body upon my desk, noting as I did so that there was the slightest movement of the body. I took a scalpel, and holding the tail in one hand, started to cut off the rattles. The snake had no sooner been touched by the blade of the scalpel than it snatched its tail away, rattled viciously, and struck at my hand with its headless neck three times. I postponed the skinning until a later time.

The snake was a small one, being about eighteen inches in length, with five rattles. It was killed at an elevation of about 1,150 feet.

Some weeks later I found another of the same species stuck fast in a pool of the crude oil with which the Santa Fe track is sprinkled. Large numbers of small animals, especially mice, lose their lives in this manner. In places the track is nearly covered with the remnants of dead bodies.

HENRY W. MAYNARD
COAST AND GEODETIC SURVEY,
KINGMAN, ARIZONA,
May 30, 1909

QUOTATIONS

A LONGEVITY TRUST

THE term "life insurance" never meant the insuring of lives until this year, when Dr. Burnside Foster and Professor Irving Fisher interested the life companies in their plans of preventing premature death. One company has this week announced its purpose to save one third of the amount awarded for death claims of tuberculous policy holders by a campaign of cure and prevention. The agents of the companies might easily be transformed into a militant body of health agents, armed with pamphlets and advice to each holder of the millions of policies. A staff of visiting physicians, specialists in the chief diseases, may treat patients in every community who can not otherwise command skilled services. By such work the companies would have fewer death claims to pay. They could promise larger benefits. But this, which has hitherto been a deciding argument in insurance competition, is only incidental to the added promise that the policy holder's life, which is of quite inestimable value to his family, would be guarded.

The competition of the life companies, once started toward the prolongation of their patrons' lives, will not end until not only tuberculosis but all the diseases that figure largely in the actuarial tables become the subject of skilled attention. The lives of most men who can afford to employ a doctor are already "insured." Ultimately, we presume, those physicians not retained by the companies would be reduced to treating minor ills, or they would be forced quite out of their profession.

The organization of preventive medicine has reached startling proportions, but it has failed to keep pace with the progress in medical science. This progress is so rapid that the medical colleges complain that they can not catch up in their equipment. But if the new departure in life insurance means anything, it means that the companies are beginning to resolve themselves into what they have an inherent right to be, companies of physicians—a longevity trust.—The New York *Times*.

SCIENTIFIC BOOKS

GAUDRY ON PYROTHERIUM [1]

THE venerated author of "Les Enchaînements du Monde Animal" was engaged until within a few days of his death upon a series of monographs dealing with the fossil mammalian faunæ of Patagonia and based upon specimens collected for the Paris Museum by M. André Tournouër.

The first of these monographs[2] dealt with

[1] "Fossiles de Patagonie: le *Pyrotherium*," *Ann. de Paléontologie* (Boule), tome IV., 1909, pp. 1–28, pll. I.–VII.

[2] "Fossiles de Patagonie—Dentition de quelques Mammifères," *Mem. de la Soc. géol. de France, Paléontologie*, Mem. XXXI., 1906, 4° (42 text figures).

the dentition of the extinct Patagonian "ungulates" and edentates, and showed in how many instances they exhibit strong but entirely homoplastic resemblances in the dentition to mammals of the northern hemisphere. The second memoir[3] made similar comparisons with respect to the limbs and endeavored to determine the pose of some of these anomalous creatures. The third[4] showed that all the fossil mammals of Patagonia (at least those from the older formations) belonged to peculiar southern groups which had followed their own lines of evolution independently of the mammals of the rest of the world. The fourth[5] memoir developed the idea of economy in nature. It showed that although the Patagonian groups had, as stated, followed their own lines of evolution, yet in many cases they had made the same structural responses to changing habits and conditions as had the northern forms, the principal difference being that the characters were never associated in exactly the same combinations in northern and southern groups. M. Gaudry concludes from this that it is unnecessary "to admit two centers of creation," *i. e.*, that more probably both northern and southern groups originally had a common center of distribution. The same memoir contained a discussion of the sequence and probable time equivalents of the principal mammal-bearing horizons of South America.

The memoir on *Pyrotherium*, which has recently appeared as a posthumous publication, was intended to be the first of a series on *Astrapotherium*, *Colpodon* and other important genera which the aged but no less productive author had hoped to describe before his death.

Pyrotherium is not the least puzzling of these curious forms. Its upper and lower cheek teeth are of the bilophodont type, that is, with two straight cross crests, and they are at first sight so much like those of the Miocene proboscidean *Dinotherium* of Europe that Dr. Fl. Ameghino, the original describer of *Pyrotherium*, has regarded it as an ancestral proboscidean. It has also a single pair of procumbent lower incisor tusks which grew continuously and had the enamel band confined to the anterior surface, as in rodents and early proboscideans, while the manus ascribed to it by Ameghino, but later declared by M. Tournouër to belong to *Astrapotherium*, certainly resembles in most characters the proboscidean type.

Fragmentary remains of the genus under consideration are characteristic of the so-called "*Pyrotherium* beds" of Chubut and Deseado. The age of these beds is very differently estimated by the leading authorities. Ameghino places them in the uppermost Cretaceous, but the majority of northern paleontologists, including M. Gaudry, are unwilling to concede that the *Pyrotherium* beds are older than the Middle or Upper Eocene.

M. Gaudry's material, although by far the most complete so far collected, still leaves us with a very imperfect knowledge of the skull and feet; but it includes specimens in an excellent state of preservation of the following parts: the upper and lower jaws, with the milk and permanent dentitions, the atlas, axis, a cervical vertebra, a lumbar, a caudal, the lower part of the scapula, and a part of the ilium, a sternal bone, and fore and hind limbs complete except for the manus and pes, which are represented only by a lunar, cuneiform carpi, astragalus and cuboid.

M. Gaudry's observations upon the special characters of *Pyrotherium* may be summarized briefly as follows: The dentition differs in important details from the proboscidean types (including *Mœritherium*): for instance, the mode of wear of the cheek teeth is entirely different, the premolars are different, the milk teeth are different, the section of the procumbent lower tusks shows no suggestion of the peculiar proboscidean "engine turning." The palate is very narrow, the orbit is placed above the fourth premolar. The atlas and axis differed widely from the proboscidean type, the

[3] *Idem*, "Les Attitudes de quelques animaux," *Ann. de Paléontologie*, t. I., 1906 (53 text figures).

[4] *Idem*, "Étude sur une portion du Monde antarctique," *ibid.*, t. I., 1906 (27 text figures).

[5] *Idem*, "De l'Economie dans la nature," *ibid.*, t. III., 1908 (71 text figures).

atlas not being pierced by the vertebral artery and having a prominent median hypapophysis, the odontoid of the axis being very large and short and supported on the enormous anterior border, while the neural tunnel in both bones is very circumscribed. The head was probably pointed downward and M. Gaudry ventures the hypothesis that the beast had the proportions of a gigantic cavy with bent fore limbs, but post-like hind limbs. A cervical vertebra is flattened, as in *Arsinoitherium* and the Proboscidea, but the lumbar vertebræ differ from the latter type. The most striking contrast with the Proboscidea lies in the forearm. The scapula has the spine turned forward instead of backward, the coracoid process is very long and prominent, the glenoid greatly extended. The massive humerus is extremely broad with very stout ento- and ecto-condylar and deltoid crests, large tuberosities and an enormous head. The radius and ulna are also very stout but absurdly short. M. Gaudry concludes from a study of the muscular attachments that the very powerful forearm may have been used in digging. The lunar and pyramidal (cuneiform) resemble those of *Elephas*, but are narrower. The acetabulum, as in the elephants, faced downward rather than outward. The straight hind limb had a long femur held almost in line with the tibia; the astragalus was greatly flattened and the navicular facet was directly below the tibial facet, and this indicates that the foot was strictly rectigrade, *i. e.*, with the digits in line with the tibia. To compensate for the relative immobility of the pes the knee joint could double up at a very sharp angle.

Upon this material M. Gaudry bases the important conclusion that *Pyrotherium* is not an ancestral proboscidean, and that all its resemblances to members of that order result from the assumption of bilophodont cheek teeth and post-like, rectigrade hind limbs; that these resemblances are accompanied by more numerous and fundamental differences, and that, in brief, *Pyrotherium* is not closely related to any other of the great "pachyderms" of different orders, such as *Astrapotherium*, *Dinoceros*, *Arsinoitherium*, *Brontotherium*, etc., and does not fit into any known order. This being the case, it seems rather unfortunate that M. Gaudry did not indicate by what name the new order containing *Pyrotherium* should be called.

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Righthandedness and Lefthandedness, with Chapters treating of the Writing Posture, the Rule of the Road, etc. By George M. Gould, M.D. Pp. 210. Philadelphia and London, J. B. Lippincott Company. 1908.

Since the appearance in 1891 of Sir Daniel Wilson's "The Right Hand: Left-handedness," no volume, besides the present one, treating of that subject exclusively, has been published. Unlike Wilson's book, which treats rather of the archeological evidences of the origin, and the occurrence in primitive times, of left-handedness, Dr. Gould's monograph appears as the advocate of a new theory of right-handedness. In addition to this theory, according to which the predominant use of the right or left hand is determined by the dominance of the right or left eye, the pathological effects of faulty writing postures and the rules of the road, follow as corollaries to it. The theory which is by far the most interesting part of the book may be summarized in three propositions: (1) In all the higher animals in which a visual function is developed, purposive movements follow as a consequence of sight.

> To begin with, embryology demonstrates the existence of vision long before muscles, so that historically and evolutionally vision governs motility; the very cleavage of the brain in the two so independent halves of all types was doubtless due to the unilateralism and independence of ocular function (p. 45).

In animals whose eyes are placed so far laterad as to have no common field of vision, the right eye necessarily governs the movements of the right, and the left eye the movements of the left, limbs. In such animals, there is no necessity for the predominant use of one of the fore limbs; therefore, nothing analogous to right or left handedness is to be

found among them. But when a binocular field of regard has developed and objects which are placed directly in front of the animal may be seen, the preferred use, for all dexterous manual acts, of one hand over the other, becomes a necessity. What is it that determines that the right, rather than the left, hand is, as a matter of fact, preferred by some 94 per cent. of civilized men?

2. It is the eyeball. I have measured 20,000 or 30,000, and no one was perfect in shape. It is a poor and makeshift mechanism even apart from its morphology; . . . If now the right eye is the more defective, more ametropic, if its vision is poorer, more difficult, or more painful than that of the left, the left eye must be chosen to govern hand-action, and so, of course, the left hand will become habitually the more chosen, the more expert, and the more educated, for the special task, and soon the child is seen to be left-handed (p. 58).

That is to say, the hand on the side of the more perfect eye will be the hand preferred for skillful acts.

3. The centers of righteyedness, righthandedness, rightfootedness, speech and writing (with memory and intellect) must be topographically in the left cerebral hemisphere to insure speed, accuracy, and coordination of united sensation, thought, will and action (p. 55).

Whatever criticism may be passed upon certain aspects of the theory, the dependence of movement upon vision must be accepted as a fact. But, the ultimate reason for this dependence must not be lost sight of; the reason, namely, that the contraction of muscles is the final term in the sequence of events called the reflex act, of which the excitement of a sense organ is the first term. Sensation, therefore, in all conscious acts, must precede movement. From this standpoint the relation of vision to movement is not peculiar. The intimate connection between sight and action is due to the high development of the visual organ and the consequent importance of visual percepts in the mental life of the higher animals. But, that the right or left hand should come to be used exclusively for all highly specialized actions, as a consequence of the right or left eye being more nearly emmetropic than the other, seems to the reviewer to be untenable for several reasons. (1) In binocular vision it is impossible to distinguish the field of vision of one eye from that of the other. To all intents and purposes, the two eyes function as one. Even if the right eye, for example, were vastly worse than its mate, the right half of the field of vision would not be less clear than the opposite half. The whole field would suffer a uniformly distributed defect; but, unless some special test were made, the patient would be entirely ignorant of the fact that his right and not his left, eye was defective. With a uniformly dim, or a uniformly clear, field of vision where is there any motive in vision to the use of one, rather than the other, side of the body? (2) If, as the author seems to hold, the field of vision of each eye remains distinct from the other, even in binocular vision, and if each eye retains potential control of the muscles of the corresponding side of the body, it is difficult to see what has been the gain of binocular, over monocular, lateral, vision.

. . . it should be remembered that forward movement of a four-footed animal, composed of two poorly united or co-ordinated longitudinal halves, must be by means of the governors of all movement—vision. One organ of this vision was for the one badly coordinated half-body, the other for the opposite half. The brain was halved, also, but a slow and poor correlating mechanism was begun and is being improved, at present much improved. Even now the right eye is united in function with the right hand, the right foot, etc., and especially with language, the crowning achievement of humanization (p. 55).

(3) The author states that the center for "righteyedness" is in the left, and, by implication, the center for "lefteyedness" in the right, hemisphere of the brain. Now, as a matter of neurology, as, no doubt, the author is fully aware, the macular region of each retina is connected with both hemispheres, and it is only the corresponding peripheral regions of the retinas which are exclusively associated with one or the other hemisphere. Suppose, now, that the right eye of an infant of six months were normal and the left eye badly astigmatic. In accordance with our

author's theory, the better-seeing right eye would determine the use of the right hand (the center for the muscles of which is in the left hemisphere) in preference to the use of the left (the center for the muscles of which is in the right hemisphere). But, now, why should it? The macular region of the right retina is connected with the right hemisphere by just as short and pervious a neurone path, as with the left hemisphere. The associative neurones between the visual and motor centers of the right, are just as short and pervious as those of the left, hemisphere and, for objects situated in front of the infant, the left hand may be used as conveniently as the right. Under these circumstances, in which there are two possible paths with no advantage of one over the other, why should the nerve impulse traverse, as a matter of fact, one chain of neurones rather than the other? In the opinion of the reviewer, Dr. Gould's theory fails to answer this question. And it is only by answering this question that any theory of the dependence of motor asymmetry upon sight can hope to succeed.

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Colloids and the Ultramicroscope, A Manual of Colloid Chemistry and Ultramicroscopy. By Richard Zsigmondy. Authorized translation by Jerome Alexander. Small 8vo, xii + 245 pages, illustrated. New York, John Wiley and Sons. Cloth, $3.00.

The study of colloidal solutions has justly received considerable attention in recent years. The appearance of the German edition of Professor Zsigmondy's book in 1905 was warmly welcomed, for besides being written in the admirable spirit of a careful student, it presented results obtained by means of a new apparatus, the ultramicroscope, which opened up a new method of attack of some of the perplexing problems of solutions.

The ultramicroscope, the chief feature of which is that by means of a special contrivance the sun's rays are concentrated so as to produce a very powerful light upon the material to be examined under a compound microscope, has enabled investigators to see minute particles hitherto invisible. Thus this instrument is of value not only in studying suspensions and colloidal solutions, but also in investigating all kinds of extremely finely divided material, and so the book is of greater significance than its title would indicate. Indeed, the results that have already been obtained by means of the ultramicroscope go far toward strengthening the probability of the atomic and molecular theories of matter.

The book is especially valuable in that it opens up new avenues of experimental investigation, and it is to be hoped that the methods of ultramicroscopy may be still further improved in the near future. During the interval between the appearance of the original and the translation, additional facts concerning colloids have been accumulated by means other than the ultramicroscope; these have not been considered. But it is to be remembered that the volume does not claim to be an exhaustive treatise on colloids.

To most chemists and physicists the work of Siedentopf and Zsigmondy is perhaps already familiar. It is to be hoped that this translation of the latter's book will be read by many others, particularly by those engaged in biology and applied chemistry. The book contains two colored plates not in the original, and also some minor additions to the text. The translator has done his work well; though a less rigid adherence to the letter of the original would have resulted in better idiomatic English. The book is printed upon good paper, the type used is excellent, and the cloth binding is neat, but the price is rather high.

Louis Kahlenberg

SPECIAL ARTICLES

ANOTHER EXPLANATION OF THE HARDINESS OF GRIMM ALFALFA

In the issue of Science for December 18, 1908, attention was called to certain points in connection with the history of Grimm alfalfa in Minnesota. In that article the well-known hardiness of this strain was attributed to acclimatization, subsequent to its introduction in

this country in 1857. A critical botanical, agronomic and historical study of this strain has been made by the writer during the past three years. These observations indicate that another explanation of the hardiness of this alfalfa is at hand. Instead of its being pure *Medicago sativa,* as has generally been supposed, it appears to possess a small proportion of *Medicago falcata* in its ancestry. *M. falcata* is the hardy drought-resistant yellow falcate podded alfalfa found wild in Eurasia. Its hardiness and drought resistance are shown by its natural growth on the dry cold steppes of Siberia, far north of the range of *M. sativa.* *M. falcata* differs from *M. sativa* in its tendency to a decumbent growth, yellow flowers instead of violet, falcate instead of three-coiled pods, tendency to produce supernumerary leaflets, greater resistance of the leaves to frosts, and smaller seeds. The hybrids between *M. sativa* and *M. falcata* show a mass of varying but usually intermediate forms. The flower color shows great variation in the different hybrids and many of the individual plants show a progressive color change, passing from violet in the bud or young flower through blue, green, greenish-yellow, and some may reach an almost pure yellow before the flower withers. This is a somewhat unique form of inheritance in that the flowers first show the influence of the *M. sativa* parentage and later the influence of the *M. falcata* ancestor. In all the characters, as well as in the size of the different floral parts, the Grimm alfalfa shows slight but definite departures from the corresponding characters of *M. sativa* toward those of *M. falcata.* Of the agronomic characters, the hardiness and recently noted drought resistance are most noteworthy. The slightly greater tendency of the plants of the Grimm alfalfa to lodge does not materially affect the usefulness of the strain. The presence of variegated flowers showing colors changing progressively from violet to blue, green and sometimes approaching and even reaching yellow, is perhaps the most noticeable characteristic. While about two thirds of the plants produce flowers of the violet of ordinary alfalfa; in about one third other colors are shown in the flowers, many of which show the progressive color changes as indicated above.

Similar studies have also been made of several other strains which have proved themselves to be both very hardy and drought resistant. So far as observed these have shown the variegated flowers and other correlated characters as noted for the Grimm alfalfa. The most noteworthy example of this is the commercial sand lucerne. This has proved on trial to be much nearer ordinary alfalfa than the botanical and agronomic literature on the subject would indicate. The original sand lucerne was apparently strictly intermediate between *M. sativa* and *M. falcata.* These forms are decidedly unstable and readily cross with ordinary alfalfa, whether it be grown in adjacent fields or from the seed having been consciously or unconsciously mixed. It has been found impossible to secure the original form of sand lucerne on the market and the commercial form is all that appears to be obtainable. Experiments by the writer indicate that the pollen of ordinary alfalfa is prepotent over the pollen of the hybrid plants' own pollen. The successive intercrossing with ordinary alfalfa offers an explanation for the close approach to ordinary alfalfa, while still retaining many traces of the *M. falcata* parents, especially the hardiness and drought resistance.

In advancing the influence of the *M. falcata* as the primary explanation of the hardiness of the Grimm alfalfa it was found that the consensus of opinion among the old neighbors of Mr. Grimm is that Grimm alfalfa has not materially increased in hardiness since it was introduced into this country. In the issue of the *Farm Stock and Home,* Vol. 20, page 65, the following statement is made:

> It [Grimm alfalfa] was grown successfully from the start, but for many years not much attention was paid to it and no great quantity was grown.

In a circular entitled "Grimm's Everlasting Alfalfa," published by Mr. A. B. Lyman, of Excelsior, Minn., who first called attention to the hardiness of this alfalfa, the author states as follows:

Some one has attributed the extreme hardiness of this alfalfa to acclimatization, assuming that it was a tender variety originally. We have made a careful investigation and can not find one thing to show but what this alfalfa was originally perfectly hardy. There is no doubt that there would be some change in over fifty years of growth in Minnesota. We have lately talked with Albert Gerdsen, now over eighty years old and a neighbor of Mr. Grimm, and he says that Grimm's log stable was always well filled with this hay after he had a start.

The statement made by a member of the Minnesota Agricultural Society in the proceedings of that society for 1903, that some of the early attempts to produce this alfalfa met with discouraging results, is explained by a son-in-law of Mr. Grimm to mean that the discouraging results experienced by some were due to improper seeding and location of the alfalfa fields. Those who gave proper attention to details were said not to have met with the discouraging results. It is possible that the member of the Agricultural Society was referring to some other alfalfa, since he states that the alfalfa to which he refers was brought in by Swiss immigrants; whereas, the Grimm family had been residents of Baden, Germany.

The "Alt Deutsche Fränkische" lucerne, as determined by both Mr. Brand and the writer, belongs to this same group of variegated alfalfas as do the commercial sand lucerne and Grimm alfalfa. This is said to be much more enduring under unfavorable situations than is the ordinary alfalfa. It is the sort commonly cultivated in the section from which Mr. Grimm originally came and it is quite possible that this constitutes the original stock from which he secured his seed.

The apparent correlation between the variegated flowers and associated characteristics of hardiness and drought resistance, makes it of great moment to determine if it is not possible that these dilute hybrids are possessed of such qualities as hardiness and drought resistance without the tedious selective elimination called for in the acclimatization of a hardy strain from ordinary alfalfa. It is in all probability true that any non-hardy individuals present in the original seed have succumbed, but the fact remains that there was apparently present a considerable percentage of hardy plants in the Grimm alfalfa at the time of its introduction into this country. The presence of several rather definite different forms, both in the Grimm alfalfa and in the commercial sand lucerne and in about the same proportions in each, would indicate that there has been little wholesale elimination of the Grimm alfalfa individuals. It may further be stated that the Grimm alfalfa is not perfectly hardy even at the present time in Minnesota, since the state experiment station has been compelled within the past ten years on at least two occasions to plow up fields, owing to winter-killing the first or second winter. It is, however, much hardier than ordinary alfalfa, and the studies above referred to indicate that the primary explanation of the hardiness of this strain is in all probability the presence of the apparent small percentage of *M. falcata* in its ancestry, rather than by reason of acclimatization, since its introduction into this country.

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A CASE OF DIPLACUSIS DEPENDING UPON THE TYMPANIC MECHANISM

UNDER the title: "The Rôle of the Tympanic Mechanism in Audition,"[1] W. V. D. Bingham reports a rather unusual case, in which the sensibility for hearing remained almost normal after the removal of the tympanic membrane and the first two auditory ossicles from both ears. In that connection a description of the following case of "diplakusis binauralis disharmonika," may be of interest. This is not reported with the assumption that the case is in all respects unique, though I do not find in the literature of the subject anything wholly similar to the present one. The case under discussion is also of special value on account of the fact that the patient is a musician of exceptional talent and training, having been for a number of years president

[1] *Psychol. Rev.*, XIV., 229-243, "The Rôle of the Tympanic Mechanism in Audition."

of the most important musical organization of Sacramento, California.

The condition had its origin in what the patient described as an attack of "earache." The first indication of abnormal hearing showed itself in an apparent repetition of sounds. This was specially noticeable when the patient spoke, "the effect being that of two people saying the same word, one slightly in advance of the other." Investigation showed that the left ear received the sound slightly in advance of the right. In listening to children the effect of the abnormality was more emphasized than was the case when the voices of adults were heard. A piano test showed that the tone reaching the right ear was half a tone higher in pitch than that of the left. The difference in time and pitch appeared definitely only above f, on the piano. All tones below that seemed to reach the two ears simultaneously, but the effect was as if the tone and its sharp had been struck together, or as if one had struck a grace note half a tone removed in pitch in each case. It is a familiar enough fact that a short temporal interval between low tones is less easily distinguished than the same interval between high tones, so that the difference in experience with tones below f, and those of higher pitch may be explained without supposing that the ears reacted in a different way for high and for low tones. This may account for the fact that the abnormal effect was emphasized in the case of children's voices. This difference in pitch perception was further tested, by placing a tuning fork first at the right ear and then at the left, with the result that the patient heard first the eighth and then the seventh of the scale.

The sensibility of the right ear for intensity was much impaired when air conduction was used, but it was about normal when bone conduction was employed.

Notes on the medical examination, for which I am indebted to H. L. McGavren, showed a rather acute state of inflammation in the tympanic membrane of the right ear; the left ear was slightly affected in the same way. There was a marked pharyngitis and a less developed laryngitis. Hearing in both ears was improved to some extent immediately after inflation by the Politzer method. McGavren adds: The entire line of symptoms indicates a middle ear complication rather than any primary affection of the organ of Corti. The fact that with bone conduction the perception of intensity was about normal whilst in the case of air conduction it was much below the normal, would seem to be conclusive on this point.

There are three points in this case which may be of interest from a theoretical point of view: (1) The temporal separation of the sounds of the two ears, respectively, (2) the difference in pitch of the tones from the two ears, (3) the fact that the perception of intensity was about normal with bone conduction, and much below the normal with air conduction.

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THE AMERICAN CHEMICAL SOCIETY DETROIT MEETING

THE meeting of the American Chemical Society held at Detroit, June 29 to July 2, was more largely attended than any summer meeting in its history and all the members returned to their homes enthusiastic over the work accomplished by the various divisions of the society.

Meetings were held by the Division of Industrial Chemists and Chemical Engineers, the Division of Physical and Inorganic Chemistry, the Division of Organic Chemistry, the Division of Fertilizer Chemistry and the Division of Agricultural and Food Chemistry and by the Sections of Biological Chemistry and Pharmaceutical Chemistry and the Section of Chemical Education. In all 186 papers were presented.

Besides the reading of the various papers the points of special interest were the largely attended meetings of the Division of Industrial Chemists and Chemical Engineers, which are continually growing in enthusiasm and where representatives were present from all parts of the country. Perhaps the "experience meeting" before this division on Friday morning was the most entertaining feature of their program, for many ideas of value were brought out and the discussion was general. It seemed as if almost every member had some interesting fact which bore upon the experience of others and the hour for adjournment was delayed

to the very latest possible moment on account of the keen interest aroused. It is quite noteworthy that the mantle of secrecy which has enveloped so many of the chemical industries and industrial chemists in the past appears to be falling away under this enthusiasm and both the industries and the industrial chemists themselves find that they gain more than they lose thereby. In this connection it might be added that a considerable number of chemical corporations are joining the society as such and are heartily entering into the spirit of progress with which the society is so thoroughly imbued.

The Section of Pharmaceutical Chemistry, which held its first meeting in Baltimore, was surprisingly well attended at Detroit with representative pharmaceutical chemists from various sections of the country. The chief matter of importance before the section was the question of the advisability of forming a Division of Pharmaceutical Chemistry. After the matter was discussed by almost every one present and many letters were read from pharmaceutical chemists, it was unanimously voted to request the council to establish such a division and a strong organization was formed with Professor A. B. Stevens, of Ann Arbor, as chairman; B. L. Murray, secretary; J. P. Remington, Edw. Kremers and J. M. Francis, executive committee.

The social features of the meeting were many. A complimentary smoker was given by the Society of Detroit Chemists to the visiting chemists on Tuesday evening and a banquet on Thursday night. On Wednesday afternoon the chemists were the guests of Parke, Davis & Co., and visited the works of this well-known firm, were entertained there at dinner and were given an evening boat ride on the Detroit River and Lake St. Claire before returning. Thursday was spent in Ann Arbor as the guests of the regents of the University of Michigan and three papers of general interest were there presented in general session. The rest of the day was turned over to the Section of Chemical Education, where papers dealing with methods of instruction were read. During the day the members visited the new laboratories of the University of Michigan and were entertained at luncheon through the courtesy of the regents.

Many manufacturing works and chemical establishments were opened to the visitors in Detroit, among which may perhaps be especially mentioned Acme White Lead and Color Works, Detroit Salt Company, Hiram Walker & Sons, Hoskins Manufacturing Company and the various automobile factories which have so greatly added to the industrial life of Detroit.

A steadily increasing number of members of the society are making it a point to attend the meetings and it is interesting to note that more and more chemical corporations are appreciating the value of these meetings to their chemists and are insisting upon their attendance, in most cases bearing all the expenses of the trip.

CHARLES L. PARSONS,
Secretary

SOCIETIES AND ACADEMIES

THE NORTH CAROLINA ACADEMY OF SCIENCE

THE eighth annual meeting of the North Carolina Academy of Science was held at Trinity College, Durham, N. C., on Friday and Saturday, April 30 and May 1, 1909, with twenty-seven members in attendance. Friday afternoon and the whole of Saturday were devoted to the reading of papers. This meeting was the most successful in the history of the academy, both in the matter of attendance (55 per cent. of the members being present) and with regard to the number of papers read.

On Friday night Dean W. P. Few welcomed the academy to Trinity College, and retiring president T. Gilbert Pearson responded on behalf of the academy. Then Mr. Pearson, who is secretary of the National Association of Audubon Societies, delivered a lecture, illustrated by stereopticon slides made from photographs taken by himself, on "The Work of the Audubon Society in Preserving Rare Forms of Bird Life." Following this a reception was tendered the members of the academy by the faculty of Trinity College.

In the business meeting on Saturday morning, the report of the secretary-treasurer showed that the academy was in excellent condition both from the standpoint of finance and of activity and enthusiasm of its membership. Six new members were elected.

The officers elected for the ensuing year are:

President—W. C. Coker, University of North Carolina, Chapel Hill, N. C.

Vice-President—W. H. Pegram, Trinity College, Durham, N. C.

Secretary-Treasurer—E. W. Gudger, State Normal College, Greensboro, N. C.

Executive Committee—H. H. Brimley, State Museum, Raleigh, N. C.; C. W. Edwards, Trinity College, Durham, N. C.; W. S. Rankin, Wake Forest College, Wake Forest, N. C.

The following papers were presented:

The Chemistry of Scrape Formation: CHAS. H. HERTY, University of North Carolina, Chapel Hill, N. C.

"Scrape" is the hardened resinous mass which forms gradually on the scarified surface of certain pines during the turpentine season, March to November. Determination of the unsaponifiable matter in various oleo-resins shows that the amount of this material is relatively high in trees which do not form scrape (*Pinus heterophylla*) and low and variable in scrape-forming trees (*Pinus palustris*). The explanation is offered that the amount of scrape formed is approximately inversely proportional to the per cent. of unsaponifiable matter present, this being a honey-like, non-crystallizable substance which acts as a retardant of crystallization in the oleo-resin after it exudes from the tree. Confirmation of this idea is furnished by analyses of the oleo-resins of Loblolly pine (*P. tæda*) and old field pine (*P. echinata*).

The Great Comet Next Spring: JOHN F. LANNEAU, Wake Forest College, Wake Forest, N. C.

A Study of Varieties: W. N. HUTT, Department of Agriculture, Raleigh, N. C.

Plants of economic value being subject to domestication usually give rise to numerous varieties.

Horticultural plants afford better material for study than agricultural, because the latter are usually treated collectively while the former are necessarily treated as individuals.

Varieties of a century ago as listed by Wm. Coxe, of Burlington, N. J., in 1818 as compared with modern varieties.

	No. Listed by Coxe.	Listed Now.
Apples	133	2,138
Pears	65	2,567
Peaches	38	449
Plums	18	522

Of the 133 apples listed by Coxe 43 or 32 per cent. of them are of foreign origin. Now exclusive of recent Russian importation but four are found in present variety lists. Variety lists are becoming more and more native American.

Pear varieties are largely foreign, but most useful varieties for American conditions are natives, *e. g.*, Seckel, Keifer.

Of early varieties of apples as listed by Coxe but nine are found in lists of to-day. Of 2,138 varieties of apples in modern lists only 85 are the result of seed planting and selection. All remainder are chance seedlings. The life of a chance seedling is a good example of the "fortuitous law of chance." One may survive, millions are lost. Reasons for varieties not "coming true." Reasons for "running out" of varieties.

The history of the corn is an example of variation. The tomato is in a state of evolution due to high feeding under domestication.

The impossibility of obtaining ideal varieties is because our ideals advance with our knowledge and many of the characteristics we would want in an ideal variety are incompatible in one individual.

Ideals are well illustrated by opposites. We want: apples that will grow farther south, peaches that will grow farther north, pears that will not blight and that have no grit and sand in them, oranges that are not bitter and pithy, quinces that are not wooden, grapes without seeds, berries that are not seedy, and the small boy wants the stomach-acheless green apple. In short, we want the rainbow, but as we advance it ever recedes.

Social Science: Report on the White House Conference on Care of Dependent Children: W. B. STREETER, Superintendent the North Carolina Children's Home Society, Greensboro, N. C.

Syllabi of Conference Resolutions

1. Home Care: Children of worthy parents or deserving mothers should, as a rule, be kept with their parents at home.

2. Preventive Work: Society should endeavor to eradicate causes of dependency like disease and to substitute compensation and insurance for relief.

3. Home Finding: Homeless and neglected children, if normal, should be cared for in families, when practicable.

4. Cottage System: Institutions should be on the cottage plan with small units, as far as possible.

5. Incorporation: Agencies caring for dependent children should be incorporated, on approval of a suitable state board.

6. State Inspection: The state should inspect the work of all agencies which care for dependent children.

7. Inspection of Educational Work: Educational work of institutions and agencies caring for dependent children should be supervised by state educational authorities.

8. Facts and Records: Complete histories of dependent children and their parents should be recorded for guidance of child-caring agencies.

9. Physical Care: Every needy child should re-

ceive the best medical and surgical attention, and be instructed in health and hygiene.

10. Cooperation: Local child-caring agencies should cooperate and establish joint bureaus of information.

11. Undesirable Legislation: Prohibitive legislation against transfer of dependent children between states should be repealed.

12. Permanent Organization: A permanent organization for work along the lines of these resolutions is desirable.

13. Federal Children's Bureau: Establishment of a federal children's bureau is desirable, and enactment of pending bill is earnestly recommended.

The Planet Mars: JOHN F. LANNEAU, Wake Forest College, Wake Forest, N. C.

The Photographic Equipment of a Biological Laboratory and Some Micro-photographs Useful in Teaching: H. V. WILSON, University of North Carolina, Chapel Hill, N. C.

The photographic equipment of the new biological laboratory of the University of North Carolina was described. For life-size photographs or reductions a Bausch and Lomb Tessar lens used in a Century View camera mounted on a Folmer and Schwing tilting laboratory stand, has proved useful. For low magnifications the Zeiss micro-planars 4 and 5 held in a Century View camera or in a Zeiss horizontal-and-vertical camera are used, with either reflected or transmitted light. In the latter case the object (an entire microscope slide, for instance, covered with growing organisms) is placed on a wooden box over a very large aperture through which the light is sent from a large plane mirror. For micro-photographs the Bausch and Lomb apparatus is used, either with a Thompson automatic electric lamp or with an acetylene lamp so made as to fit the same light box. For freshly mounted balsam or for glycerine slides the vertical microscope with prism-arrangement offers great advantage. For low magnifications of large fields the Zeiss micro-planars 1–3 without ocular warrant the praise that has been given them. The microphotographs exhibited were of preparations illustrating points of general interest in the fields of vertebrate embryology and histology.

New Occurrences of Monazite in North Carolina: JOSEPH HYDE PRATT, State Geologist, Chapel Hill, N. C.

College Entrance Requirements in Science in North Carolina: C. W. EDWARDS, Trinity College, Durham, N. C.

An Alteration in the Direction of Growth that may be Induced in Sponges: H. V. WILSON, University of North Carolina, Chapel Hill, N. C.

One of the common sponges in Beaufort harbor, *Stylotella* sp., develops oscular lobes which grow up toward the surface of the water when the sponge rests on the bottom. If now such a sponge with a set of well-developed lobes be laid on its side in a large aquarium, growth takes place at many points on the lobes and at right angles to their long axis. This growth leads in the course of a week to the development of a new set of oscular lobes which again extend up towards the surface of the water but at right angles to the former lobes, whose terminal oscula have now disappeared.

The Wistar Institute Journals and the Need for their Support: H. V. WILSON.

It was pointed out that growth in the biological departments of colleges led to the need of suitable organs for publication, and that it was to the manifest interest of these departments to lend financial support to such journals as those of the Wistar Institute.

A New Species of Water Mold: W. C. COKER, University of North Carolina, Chapel Hill, N. C.

In October, 1908, a species of *Leptolegnia* was found at Chapel Hill, N. C., and has been kept growing in the laboratory since. It proves to be near the long lost *Leptolegnia caudata* DeBary of Germany, but seems to be distinct enougn to be considered a new species.

Delayed Opening of Cones in Certain Species of Pines: W. C. COKER.

Cones of *Pinus tuberculata* from California and *Pinus serotina* from South Carolina were shown. Though mature for about eight years they had not opened. This tendency is developed to such an extent in *P. tuberculata* that the cones seem never to open until the wood on which they are borne is dead.

Exhibit of a Double-flowered Sarracenia and a New Variety of Elliott's Gentian: W. C. COKER.

Double flowers of *Sarracenia rubra* were shown from Hartsville, S. C. They have not before been known in the genus. Other specimens exhibited were a white variety of *Gentiana Elliottii* from Society Hill, S. C., and leaves and fruits of *Acer floridana* from Chapel Hill, N. C.

Some Notes on the Song Periods of Birds: C. S. BRIMLEY, Raleigh, N. C.

The writer commenced taking notes on what species of birds were in song at Raleigh, N. C., during the last week of June, 1908, and this paper gives the results obtained up to the end of April, 1909.

On the Number of Species of Birds that can be Observed in One Day at Raleigh, N. C.: C. S. BRIMLEY.

This paper enumerates the total number of species observed in each month at Raleigh, N. C., from November, 1908, to April, 1909, inclusive, and also gives the greatest number observed in any one day in each of the months, with a full list of the species observed on the best days in November, January, March and April.

Geology and the Lumber Market: COLLIER COBB, University of North Carolina, Chapel Hill, N. C.

Studies in Soil Bacteriology, III.: Concerning Methods for Determination of Nitrifying and Ammonifying Powers: F. L. STEVENS and W. A. WITHERS, assisted by J. C. TEMPLE, W. A. SYME, J. K. PLUMMER and P. L. GAINEY, North Carolina Experiment Station, Raleigh, N. C.

Observations on Bird Life of Great Lake, Craven County, North Carolina: H. H. BRIMLEY, Curator State Museum, Raleigh, N. C. (Read by title.)

Senses of Insects: FRANKLIN SHERMAN, JR., Entomologist, Department of Agriculture, Raleigh, N. C.

This paper merely reviews the well-understood facts in regard to the senses of insects, the organs of special sense, their location, etc. No claim is made for originality in the matter presented.

The antennæ are declared to be the most important organs of special sense, as they serve as organs of both touch and smell, and apparently in some cases (mosquitoes of the genus *Culex*) as organs of hearing also.

Methods of Reproduction among Insects: Z. P. METCALF, Department of Agriculture, Raleigh, N. C.

Some Unrecognized Factors Affecting the Potential Difference Developed in an Induction Coil: C. W. EDWARDS, Trinity College, Durham, N. C. (Read by title.)

Oral Gestation among Teleostean Fishes: E. W. GUDGER, State Normal College, Greensboro, N. C.

Oral gestation is not uncommonly practised by siluroid and cichlid fishes. Many marine, estuarine and fresh-water catfishes of Central and South America, India and Australia carry their eggs and young in their mouths. With one possible exception, it is always the male who thus incubates the eggs.

Among the cichlids of South America, Africa and Syria this habit is very prevalent. In these fishes it is generally the females who thus care for their progeny.

Scattering cases of this habit among other teleosts are occasionally met with, especially among species belonging to the genera *Apogon* and *Cheilodipterus*. It seems probable that further research among these latter forms will extend our knowledge of this curious habit which is invariably associated with unusually large size of the eggs.

The writer has been engaged for fifteen months in working up the literature of this extraordinary habit in fishes. This work is being done for the Bureau of Fisheries, and will be issued in its publications.

The Linear Classification of the Cubic Surface: ARCHIBALD HENDERSON, University of North Carolina, Chapel Hill, N. C.

The speaker considered the twenty-one different types of the cubic surface (neglecting the two scrolls) reduced to canonical form with reference to the straight lines lying wholly upon the surface. By proper choice of constants, he succeeded in representing, in each case, the lines in position with reference to the fundamental tetrahedron. He exhibited diagrams, in color, of the lines, with proper reference to each other and to the fundamental tetrahedron, for all twenty-one types of the cubic surface.

The Terminal Bud of the Sweet Gum, Liquidambar styraciflua: E. W. GUDGER, State Normal College, Greensboro, N. C.

This tree has on the ends of its lateral branches terminal buds of two kinds. One is of ordinary size and contains only leaves and an embryonic branch. The other kind is very large and swollen. Dissection or subsequent development on the tree shows that this contains a cone made up of the familiar sweet gum balls—it is seemingly a terminal bud devoted solely to the production of flowers. Later, the lowest ball (sometimes the two lowermost) develops an extraordinarily long pedicel, and the stem bearing the cone breaks off just above the point of attachment of this pedicel leaving but one ball of the six or eight to come to maturity. About this time a very small leaf bud makes its appearance just below the base of the cone and this lateral bud later becomes the terminal bud which by its growth elongates the branch.

Social Science: The Work of the Woman's Association for the Betterment of Schools: Mrs. Charles D. McIver, Field Secretary Woman's Betterment Association of North Carolina, Greensboro, N. C.

Notes on the Petrography of the Granites of Chapel Hill, N. C.: H. N. Eaton, University of North Carolina, Chapel Hill, N. C.

Some Results of Municipal Milk Inspection in Raleigh, N. C.: F. L. Stevens, North Carolina Experiment Station, Raleigh, N. C.

E. W. Gudger,
Secretary

THE TORREY BOTANICAL CLUB

The meeting of May 26, 1909, was held at the museum of the New York Botanical Garden and was called to order at 3:30 P.M. by President Rusby. Thirty-four persons were present. After the reading and approval of the minutes of the preceding meeting, the scientific program was presented, the first contribution being made by the president, Dr. H. H. Rusby, who spoke of "The Earliest Spring Flowers in the Vicinity of Charleston, South Carolina."

The speaker's remarks were based on observations made between March 16 and March 23, 1909, at Summerville, which is about twenty-two miles northwest of Charleston. By a careful comparison of the state of vegetation there in March with that of New York and vicinity in May, it was concluded that there was a difference of eight or nine weeks this year in the progress of the season, though it is probable that in an ordinary year the difference would be about seven or eight weeks.

Summerville is noted for the existence there of Dr. Shepard's tea-gardens, the only tea plantation conducted on a commercial scale in this country. There are now about 100 acres of plantation in productive operation there, from which 12,000 to 15,000 pounds of tea are sold annually. Success has been obtained through an extensive series of experiments with all the known varieties of the tea plant. No attempt is made to compete with the Orient in the cheaper grades of tea, but in the more highly prized grades the Summerville product is already taking a leading rank.

The plants collected at Summerville by Dr. Rusby were then discussed and exhibited in groups, arranged according to habitat and time of flowering.

Dr. Britton in discussing Dr. Rusby's paper referred to the popular belief among the fruit-growers of Delaware that the spring advances northward at the rate of thirteen miles a day—a belief that would seem to be supported by Dr. Rusby's observation that there is a difference of seven or eight weeks in the progress of the season between Summerville, S. C., and New York.

The second paper on the scientific program was by Dr. J. A. Shafer on "Botanizing in Cuba." Dr. Shafer was in northern Cuba from January 22 to May 6 of the present year in the interests of the New York Botanical Garden. He gave a popular account of his collecting experiences there and of the general floral features of the regions visited. Headquarters were established at La Gloria, Nuevitas and Holguin, and shorter visits were made to Gibara, Cacocum, Alto Cedro, Paso Estancia and Antilla.

One of the objects of the expedition was to ascertain whether the flora of northern Cuba had any relation to that of the adjoining Bahamas, which islands have been the subject of extensive floristic investigations by Dr. Britton and others; but on the northern mainland of Cuba one notes little relationship.

Cayo Guajaba, one of the chain of outlying northern islands, none of which seems to have been visited by botanists heretofore, probably on account of the difficulty of access, was examined at several points and was found to possess a very different flora from that of the mainland south of it, many of the species being Bahamian.

North of Nuevitas, the railroad to Camagüey passes through many miles of rather barren palm-covered savannas, through which an occasional stream passes, whose winding course can readily be made out by a fringe of green trees, overtopped by the graceful heads of the royal palm. From Camagüey to Holguin, a distance of about one hundred and fifty miles, one passes alternately through stretches of dry savannas, rich dense woods and fertile pastures.

Paso Estancia, towards Santiago, on the Cauto River, was made the last place from which extensive explorations were carried on. The river, which is the largest in Cuba, here passes between high bluffs made up of stratified limestone and clay or sand. It has many turns, with gravelly bars and sandy or muddy banks, and many things can be found there. The surrounding country is a dense forest, with a great variety of species.

After a discussion of Dr. Shafer's paper by Dr. and Mrs. Britton, Dr. Rusby and others, adjournment followed.

Marshall A. Howe,
Secretary pro tem.

SCIENCE

Friday, August 13, 1909

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of Science, Garrison-on-Hudson, N. Y.

THE AEROLOGICAL CONGRESS AT MONACO

The international study of aerology, as the exploration of the atmosphere is now called, was begun by a small commission, including the writer as the American member, which was appointed at an International Meteorological Congress held at Paris in 1896. Although the commission bears the title "International Commission for Scientific Aeronautics," aeronautics serves only as the means of obtaining meteorological data in the free air. The work of the organization rapidly extended and five meetings were held in European cities before the session this year, which, by invitation of its honorary member, Albert I., Prince of Monaco, occurred during the first week of April in the new Oceanographic Museum at Monaco. The interest and importance of this, the sixth, reunion, served to bring together about thirty colleagues, from fourteen nations, the writer representing the United States Weather Bureau besides his own observatory at Blue Hill, where the first aerological observations in America were undertaken.

The meeting on April 1 was opened by Professor Hergesell, of Strassburg, president of the commission, who reviewed the progress made in exploring the air since the meeting at Milan three years ago, dwelling particularly on the extensive cooperation in the simultaneous series during six days in July, 1908, when balloons and kites were sent up from forty-four stations on land and sea in the northern and southern hemispheres. He emphasized the importance of determining the direction of the wind at different heights

by observing pilot-balloons with theodolites.

The Prince of Monaco welcomed his guests to the new Oceanographic Museum, which he hoped would become a repository for the results of soundings of the air as well as of the sea, and to his yacht, *Princesse-Alice*, on which were made marine and atmospheric soundings from the equator to beyond the Arctic Circle. In speaking of the last the prince described the launch and recovery of a *ballon-sonde* at sea.

At the business meeting which followed, Professor Hildebrandsson was named vice-president of the conference. The death of Professor Pernter was announced and Professor Trabert, his successor as director of the Austrian Meteorological Office, was chosen a member of the commission. Other new members elected were: M. Vincent, head of the Belgian Meteorological Service; Dr. Kleinschmidt, in charge of the Lake Constance Kite-station; Captain Ryder, director of the Danish Meteorological Institute; Professor Bjerknes, of Christiania; Dr. Bamler, of Munich; the directors of the Russian observatories at Irkutsk, Tiflis and Ekaterinburg, and these military aeronauts: Captains Voyer and Bouttieaux, of France: Le Clément de St.-Marcq, of Belgium, and Colonel Capper, of Great Britain.

The program for the conference was intended to include: (1) technical questions relating to balloons and instruments; (2) methods, organization and equipment of expeditions; (3) reports of researches during the preceding year; (4) other questions, including new projects.

The International Commission on the System of World-stations, a subcommittee appointed by the International Meteorological Committee, also met in conjunction with the Aeronautical Commission.

In the first group, Dr. Assmann, director of the Prussian Aeronautical Observatory at Lindenberg, described a new process of making *ballons-sondes* by dipping in a rubber solution instead of cementing sheets of rubber. The particles of dust in the latter cause the pores to open, but the dipped balloons expand five or six diameters without losing gas or bursting, permitting a greater height to be reached or a smaller balloon to be used. The parachute cords by friction on the rubber weaken it, or if two balloons are attached tandem, the smaller sets up oscillations injurious to the record; therefore Dr. Assmann proposes to put one balloon inside the other, one of them bursting on reaching the maximum altitude. He now employs a rubber captive-balloon of 14 to 17 cubic meters capacity, which loses no gas and therefore does not present pockets to the wind, and when carrying wire of 0.6 mm. diameter can reach an altitude of 4,000 meters. To avoid the chemical effect of insolation on the rubber the upper portion of the net is covered with a yellow fabric. A discussion followed as to the advantages of rubber and gold-beaters' skin for captive-balloons.

Dr. Assmann in another paper described an instrumental method to verify if, in the isothermal layer, the ventilation of thermometers is sufficient. While the upper inversion was shown as early as 1893 by the observations of Hermite and Besançon, yet for a long time it was attributed to insolation. This disturbance was later avoided by night ascensions and the descent of the balloon accelerated through letting gas escape by clockwork. The rubber balloon gives a very nearly constant velocity of ascent and this ventilation and a bright metal casing around the thermometer are generally thought sufficient. While it is doubtful whether extremely rare air can carry off heat from the thermometric strip, if there is no change when an artificial

current reinforces the downward draught, then the instrumental error may be assumed to be *nil*. Compressed air, contained in a globe of polished metal, is liberated against the thermometric strip during ten minutes by means of an aneroid barometer at the height when the inversion of temperature usually begins in cyclonic or anti-cyclonic conditions. This device has not yet been tried in the high atmosphere. The second part of Dr. Assmann's paper described an apparatus for ventilating thermometers in captive-balloons, especially during calm weather. A horizontal fan is driven by an electric battery, and a dipping-vane changes its direction of rotation when the descent begins.

In discussing the first subject, the president asked to have it noted that in spite of incredulity in some quarters regarding the reality of the upper temperature inversion, no member of this commission doubted its existence.

Professor Hergesell exhibited a new meteorograph for manned and captive-balloons having a bimetallic blade for temperature and a Vidi vacuum box for pressure, with an automatic ventilator for the former. This instrument made by Bosch, of Strassburg, weighs 1,200 grams and costs $75. A discussion followed as to the use of a straight bimetallic blade instead of a curved one.

Professor Palazzo, of Rome, described two devices for launching *ballons-sondes* at sea, in which the Bourdon barometric tube liberates one of the tandem balloons or lets out the gas. In discussing the necessity of limiting the time of the ascensions other devices for the same purpose were mentioned.

Professor Rotch urged the adoption of a uniform method of publishing the kite data and suggested the form used at Blue Hill and Mount Weather. He pointed out the confusion regarding the positive and negative sign attached to the temperature gradient in the official publication of the data derived from balloons and kites. Following the report of a committee appointed to consider the matter, the conference decided to express the gradient as positive when the temperature decreased with altitude and, in the published kite-observations, to give the simultaneous observations at the ground so far as possible.

Professor Köppen, of Hamburg, sent a memoir in which he proposed that, instead of the usual readings of the barometer, the data be expressed in absolute units of the C.G.S. system, and that the pressure be reduced to a height of 100 meters instead of to sea-level. This proposition was referred to the International Meteorological Committee.

Professor Bjerknes, of Christiania, read a paper on the theoretical application of upper air observations, in which he insisted that the object of aerological observations is to secure diagnoses about the momentary dynamic condition of the atmosphere. The series of ascensions should give data separated by such intervals as will permit the changes occurring between different diagnoses to be followed, so that by combining them it becomes possible to formulate laws by which the future state of the atmosphere may be predicted. He proposed to establish three diagnoses, namely, in the morning, at noon and in the evening, or at eight, one and seven o'clock, Greenwich time, but as the instrumental equipment will not permit all the diagnoses to be complete, that at noon is declared the principal one. At this moment kites and balloons with instruments are to be sent up and observations made at the ground which will enable the atmospheric conditions at different heights to be traced on charts. For the morning and evening diagnoses,

besides the ground observations, only pilot-balloons need be sent up, but sufficient in number to serve as a basis for charts of air movements.

Professor Bjerknes endorsed Professor Köppen's proposition to use dynamical units to express atmospheric pressure and wind-velocity, and in replying to questions as to the advantage of absolute measures he said that they avoided the introduction of constants in the application of dynamic equations and thus gave precision and simplicity. Tables facilitate the transformation of the old into the new units. Mr. Cave, of England, said that the upper-air observations in England were now published in the *Weekly Weather Report* in absolute units.

Mr. Cave read a request from his colleague, Mr. Dines, to have the *ballons-sondes* sent up about an hour before sunset to avoid insolation and yet allow them to be watched with a theodolite. Professor Rotch said that this practise had given good results in America, but the conference was unwilling to change the existing hour. It was later voted that beginning in July, complete observations be obtained as nearly as possible at 7 A.M., Greenwich time, as heretofore, but that pilot-balloons be sent up three times a day as desired by Professor Bjerknes during one of the monthly series of ascensions. There was also voted in this connection, a proposition of M. Vincent, to observe the state of the sky on the international days.

M. Teisserenc de Bort, of Paris, spoke on the result of his triangulation of *ballons-sondes* from 1898 to 1909 at Trappes and their importance for the verification of heights calculated by the barometer. The base-line used was 1,300 meters, but there is now a base of 5,000 meters. While the two methods agreed closely, the effect of hysteresis in the barometer was evident, though the temperature-correction was small. M. Teisserenc de Bort exhibited charts of some trajectories of his balloons, which showed that the cyclonic rotation ceases at a certain height and is replaced by a calm zone that marks the top of the adiabatic temperature-gradient. Above this the currents are from the south and west and opposed to the surface-wind. In the tropics, superposed currents occur with a sudden change in direction at about 7,000 meters, the absence of cyclonic storms accounting for the stratification. As to the changes of wind in the "stratosphere," or region of the upper temperature-inversion, M. Teisserenc de Bort had found only slight changes, but Messrs. Cave and Hergesell agreed that the velocity of the wind decreased there. Professor Hildebrandsson's observations of clouds confirmed those of M. Teisserenc de Bort with balloons, in showing a motion towards the north above 3,000 meters over a low-pressure area.

Continuing the technical questions, Professor Hergesell discussed the upward velocity of rubber balloons as a function of their lift and the use of pilot-balloons to determine the vertical currents of the atmosphere. In a closed space the velocity remains constant, so that, knowing the surface and free-lift of a balloon, its rate of ascent may be calculated, and there is little difference—about 4 per cent.—between the height obtained from angular observations of the balloon at one station, combined with its assumed velocity, and measurements of its height from the ends of a base-line. Successive observations of the displacement of the balloon enable the speed of the horizontal wind to be determined accurately. Often the vertical currents may be measured from angular observations at the corners of a triangular base, and a downward movement of 1.5 meters per second has been measured. In the discussion Captain

Hildebrandt, of Berlin, said that on the Peak of Teneriffe, pilot-balloons were driven down for three minutes at the rate of 2.5 meters per second and Gen. Kowanko, of St. Petersburg, mentioned the fact that when above a sea of clouds aeronauts found currents rising over the cloud summits and descending in the spaces between the clouds.

M. Teisserenc de Bort discussed the data relating to the upper isothermal stratum. Up to about 10 kilometers the decrease of temperature is almost adiabatic, then in the next 5 kilometers there is usually a rise in temperature of 8° to 10° C., with isothermal conditions up to at least 26 kilometers. The lower zone he calls the "troposphere," and the upper one the "stratosphere." The former is a region of violent atmospheric disturbances, for Hildebrandsson has shown that cyclones do not extend above the cirrus clouds, though anti-cyclones persist to greater heights, and therefore the stratosphere is lowest in the cyclone and highest in the anti-cyclone and its level sinks from the equator to the poles. The stratosphere is a region of interlaced currents and small vertical movements.

The following papers described the results of recent expeditions and investigations. General Rykatchef, director of the Central Physical Observatory, at St. Petersburg, exhibited charts of aerial soundings at various Russian stations. The higher level of the great temperature-inversion in anti-cyclones than in cyclones at St. Petersburg, and the isothermal condition prevailing in winter for several thousand meters above the ground at Asiatic stations, were some of the phenomena illustrated.

The most interesting report was presented by Professor Berson, assistant at Lindenberg Observatory, on his recent expedition to tropical East Africa and Lake Victoria Nyanza. On the coast and from a specially chartered steamer on the lake, *ballons-sondes,* pilot-balloons and kites were sent up. The observations over the equator, in the center of the continent, showed very low temperatures at great heights, as did the expedition of Teisserenc de Bort and Rotch on the equatorial Atlantic, but with the difference that over the African continent there was a trace of the isothermal layer. The vertical changes were as follows; adiabatic decrease of temperature to 13,000 meters, between 13,000 and 15,000 meters a small inversion, and above 17,000 meters isothermal conditions. Above the southeast monsoon the wind was south-southwest and three times a westerly wind was observed between 15,000 and 18,000 meters, above the great equatorial current from the east which is supposed to prevail at all heights.

Professor Palazzo, director of the Italian Meteorological Office, described his aerological expedition to Zanzibar and to the east coast of Africa, in which *ballons-sondes* and pilot-balloons were launched from an Italian cruiser. Professor Hergesell gave some results of balloons sent up from a German cruiser in the neighborhood of the Canary Islands, and on the Peak of Teneriffe. He showed the effect of the distribution of barometric pressure on the trade-wind, which is especially influenced by the displacement of the center of maximum pressure over the North Atlantic. Professor Hergesell reaffirmed his belief that the effect of the Peak on the wind extends up to 6 kilometers above sea-level. Professor Rotch presented his volume giving an account and a discussion of the first observations with *ballons-sondes* in America, which were made at St. Louis from 1904 to 1907.

The communications relating to new projects included the promises of Dr. van

Bemmelen, of Batavia, to establish a kite station there, and of Mr. Davis, a director of the Argentine Meteorological Office, to do the same in this country. M. de Massany gave an account of an aerological station about to be established at Kecskemét on the plains of Hungary, which plan received the approval of the commission.

Professor Hergesell spoke of the new observatory on the flank of the Peak of Teneriffe at a height of 2,400 meters, which he had just inaugurated in portable buildings furnished by the German emperor. Aerological stations in Spitzbergen and Teneriffe are of particular value and the desirability of the latter was expressed at the Milan Conference. Col. Vives y Vich, the Spanish military representative, took exception to some of Professor Hergesell's statements, and the following facts were agreed upon: The Aeronautical Commission was ready to establish an observatory on the peak with the aid of the Prussian government. The Spanish government objected, but recognizing the scientific value of the enterprise, it provisionally accepts the use of the temporary buildings offered by the Prussian government, through Professor Hergesell, until permanent buildings can be erected. Until such time the buildings will be considered Spanish property, and while the observatory will be open to savants of all countries, no preference can be given to Germans. The conference expressed its thanks to both the German and Spanish governments, and especially to the Spanish military aeronauts, for creating this observatory.

Professor Assmann read a suggestive paper on the application of aerological observations in aerial navigation. He cited the observations which were being made in the free air at various observatories and by expeditions on the oceans. Eventually it will be possible to construct synoptic charts of the upper air which will enable predictions to be made of great value for aerial navigation. Even now, before a dirigible balloon ascends from Berlin, the observations in the free air from four stations are consulted. These views were approved by several members and Dr. Bamler thought it possible to obtain continuous registration in a captive-balloon maintained at a constant height. In this connection the attention of the aero clubs was called to the importance of making meteorological observations in all manned balloon ascensions and the assistance rendered in this respect by the Vienna Aero Club and the Austrian Minister of War was acknowledged.

It was voted to exchange copies of the traces of the automatic records between members on their request, and to send titles of new aerological publications to the *Fortschritte der Physik* in Germany and to the *Monthly Weather Review* in the United States. The next meeting of the Commission will be held at Vienna in the autumn of 1912.

Three sessions of the Commission on the System of World-stations were held with M. Teisserenc de Bort as president and Professor Hildebrandsson as secretary. The former made a report on his project for telegraphic meteorological stations and the latter explained his proposition to the International Committee in 1899 to establish meteorological stations around the great centers of action on the globe and showed the compensating types of weather occurring simultaneously in different regions. Thirty-eight stations, at important points around the globe between 70° N. latitude and 50° S. latitude, were selected, at which, besides the ordinary elements, the direction of the upper clouds, the temperature of the sea and the insolation at fixed altitudes of the sun are to be observed at the hour of the usual morning observation, except the

insolation, which is for the preceding day. For the study of the centers of action, the monthly means of observations are to be sent by the cooperating institutes to the president of the commission, but for the other system of stations the observations are to be telegraphed every day, or, if this is impossible, the weekly means can be telegraphed and, like the daily observations, published in the weather bulletins of the respective countries where they will be available for study.

Although the week was chiefly occupied with the scientific sessions, the prince entertained members of the commissions several times at the palace and on his yacht, the *Princesse-Alice,* where he himself participated in some oceanographical investigations. These, as well as the aerological work of the prince, were illustrated by an evening lecture given by his aide-de-camp, M. Bourée. The little time remaining was agreeably filled by a visit in automobiles to the Nice Observatory and by a performance at the opera of Monte Carlo. To the writer the prince expressed the desire that with the completion of the Oceanographic Museum, the principality of Monaco should be not only a pleasure resort, but also become a scientific center, and the Aerological Congress prove the precursor of meetings of a similar nature there.

A. Lawrence Rotch
Blue Hill Meteorological Observatory,
Hyde Park, Mass.

THE DARWIN CENTENARY

ADDRESS IN REPLY TO THE RECEPTION OF DELEGATES[1]

Crossing the Atlantic in honor of Darwin and rejoicing in the privilege of uniting in this celebration of his birth, we desire, first of all, to render our tribute to the University of Cambridge.

To no other institution in any country may we turn with such a sense of filial gratitude. Through John Harvard, of Emmanuel, Cambridge became the mother of our colleges. Did not Emmanuel beget Harvard, and Harvard beget Yale, and Yale beget Princeton and other descendants to the third and fourth generation? We thus salute to-day the venerable but ever-youthful ancestor of many of the American universities, academies and institutes of science, national and state museums, represented here, and in large part guided by true sons of the true daughters of the alma mater on the Cam. Through the survival of the best, our political guidance is also passing more and more into the hands of men trained in these same daughter colleges. A son of Yale succeeds a son of Harvard as president of the United States. If your university men are leading the empire in times of stress, ours are leading the nation through the more perilous, because more insiduous, times of prosperity. Thus in ever-widening growth is the influence of the Cambridge heritage. "Sir Walter," remarked Queen Elizabeth, "I hear that you have erected a Puritan foundation." "No, madam," he replied, "far be it from me to countenance anything contrary to your established laws; but I have set an acorn, which, when it becomes an oak, God alone knows what will be the fruit thereof."

The other offspring of Emmanuel, of Trinity, of Christ's and of the many pious foundations of the old university, are the great men, too numerous to name, but among whom there especially rise in our minds Newton, Clerk-Maxwell, Balfour, and above all, Darwin. Newton opened to us the new heavens, and Darwin the new earth. Clerk-Maxwell, with Herz, enabled us to converse with you through the blue ether. The well-beloved Balfour revived the spirit of Von Baer; would that his life had been spared for the more difficult problems of our day. If in our hours of struggle with the mysteries of nature these are our leaders and companions, so in our hours of ease and relaxation do we not turn

[1] By Henry Fairfield Osborn, LL.D., Hon.D.Sc. Camb., Da Costa Professor of Zoology, Columbia University, President of the American Museum of Natural History.

again to sons of Cambridge for spiritual refreshment, to the verse of Milton, of Byron, of Wordsworth and Tennyson, all richly imbued with the nature spirit, or to the no less masterly prose of Thackeray and Macaulay?

Far away are the giant forces of our republic, the roar of her machinery and her world of trade, yet the independence of her development is more apparent than real. There still prevails the potent unifying influence of mind and motive, bred in quiet places like this, ever creating the new generations of leaders in science, in literature and in government, and ever renewing the strong bonds of friendship and of union.

What can we add to the chorus of appreciation of the great pupil of Christ's which has come from college, press and pulpit since the opening of this anniversary year? Only a few words of personal impression.

To us, Darwin, more perhaps than any other naturalist, seems greatest in the union of a high order of genius with rare simplicity and transparency of thought. Dwelling on this lucid quality and on the vast range of his observation from the most minute to the grandest relations in nature, does not the image arise of a perfected optical instrument in which all personal equation, aberration and refraction is eliminated and through which, as it were, we gaze with a new vision into the marvelous forms and processes of the living world. With this wondrous lens our countrymen, Cope and Marsh, penetrated far deeper into fossil life than their predecessor Joseph Leidy—thus the arid deserts of the Rocky Mountain region gave up their petrified dead as proofs of Darwinism. Through its new powers Hyatt, Morse, Packard and Brooks saw far more than their master Louis Agassiz, and drew fresh testimonies of development from the historic waters of New England. From the very end of the new world, where the youthful Darwin received his first impressions of the mutability of the forms of life, we enjoy a clearer vision of the ancient life of Patagonia.

What of Darwin's future influence?

While it is doubtful if human speculation about life can ever again be so tangential as in our pre-Darwinian past of fifty years ago, it is probable, in fact it is daily becoming more evident, that the destiny of speculation is less the tangent than the maze—the maze of innumerable lesser principles, with as many prophets calling to us to seek this turning or that. There are those who in loyal advocacy of his system feel that we shall not get much nearer to life than Darwin did, but this is to abandon his progressive leadership, for if ever a master defined the unknown and pointed the way of investigation, certainly it was Darwin. In the wonderful round of addresses in his honor of this Centennial Year, and in the renewed critical study of his life and writings—the recognition that Darwin opened the way has come to many with the force of a fresh discovery. It is true that he left a system, and that he loved it as his own, but his forceful, self-unsparing and suggestive criticism show that if he were living in these days of Waagen, of Weismann, of Mendel and of De Vries, he would be in the front line of inquiry, armed with matchless assemblage of fact, with experiment and verification, and not least with incomparable candor and good will. This bequest of a noble method is hardly less precious than the immortal content of the "Origin of Species" itself.

In conclusion, we delegates, naturalists and friends, desire to present to Christ's College, as a memorial of our visit, a portrait of Charles Darwin in bronze, the work of our countryman, William Couper, a portrait which we trust will convey to this and future generations of Cambridge students, some impression of the rugged simplicity, as well as of the intellectual grandeur, of the man we revere and honor.

PERIDERMIUM STROBI KLEBAHN IN AMERICA

During the past few years several millions of young trees of white pine (*Pinus Strobus*) have been imported from Europe and distributed in the northeastern states. This has been done in spite of the obvious danger of bringing in insect pests and the fungus *Peridermium Strobi* Klebahn. The latter is not

known to occur in America, but is generally distributed in Europe, where in certain sections it is very destructive. It is mentioned as being abundant about Hamburg, where are located some of the largest forest tree nurseries of the world.

The writer has repeatedly examined imported white pine trees, anticipating the introduction of this disease, and, on June 8, succeeded in finding it. This is its first reported occurrence on white pine in America. Continued investigations now show that *Peridermium Strobi* is present on imported stock in the states of New York, Vermont, Massachusetts and Connecticut. The stock was imported from the nurseries of J. Heins Söhne, near Hamburg, Germany. All of the stock found infected thus far is three years old, that is, the seed was sown in 1906. There can be no doubt that it was infected in the German nurseries, as (1) the disease was not known to occur in America on the pine previous to this date, and in no form whatever except as mentioned below; (2) fruiting pustules have been found on three-year-old trees which were imported this spring; (3) fruiting pustules have also been found on trees which were imported in the spring of 1908 and placed in transplant beds in this country.

It is a well-known fact that a fungus disease introduced into a new climate is usually much more virulent in its attacks than in its native country. This fungus prevents the cultivation of *Pinus Strobus* in certain sections of Europe where the fungus is indigenous. We can hardly doubt that it will be even more destructive should it once obtain a foothold in America. The white pine is the tree upon which depends the entire reforestation movement which has been developed in the northeastern states. *Peridermium Strobi* threatens the profitable use of this species and thus directly concerns all who are connected with the reforestation question in this section. At the present stage in this movement it would be a national calamity to allow this fungus to become established in America.

Peridermium Strobi has an alternate stage on various species of *Ribes,* which is known as *Cronartium ribicola* Fisch. de Waldh. The fungus probably will not transfer from white pine to white pine, but must pass from white pine to *Ribes,* and vice versa. The *Cronartium* stage was found established in New York in 1906 by Stewart,[1] who apparently was entirely successful in eradicating it. The *Peridermium* stage has never been previously found in this country, so far as now known. The best available method of treatment is (1) to immediately burn the diseased white pine trees; (2) to inspect all neighboring currant and gooseberry bushes in August and September, and to burn any affected plant; (3) to inspect the pine trees again in April or May of next spring (1910) and burn all that are found diseased. It may be also necessary to repeat the inspection of the currant bushes in 1910.

On June 28 a meeting was held in New York City of the representatives of the forest commissions of the states of New Hampshire, Vermont, Massachusetts, Connecticut, New York and New Jersey, the Pennsylvania and the Delaware and Hudson Railroads, the New York State Department of Agriculture, the Geneva Agricultural Experiment Station, the Yale Forest School, the Forest Service and the Bureau of Plant Industry of the United States Department of Agriculture. Concerted action along the lines recommended above was pledged by all concerned, and measures for preventing the further importation of diseased trees were taken under consideration.

PERLEY SPAULDING
BUREAU OF PLANT INDUSTRY

SCIENTIFIC NOTES AND NEWS

IT is scarcely necessary to remind readers of SCIENCE that the Winnipeg meeting of the British Association for the Advancement of Science opens on August 25, and that the council of the association has invited members of the American Association for the Advancement of Science to become members for the meeting. Abstracts of papers intended for presentation should be forwarded to the local secretaries, University of Manitoba.

[1] Stewart, F. C., Tech. Bull. N. Y. (Geneva) Agr. Expt. Station, 2: 60–74, 1906.

The French Association for the Advancement of Science will meet this year at Lille on August 2–7, under the presidency of Professor Landouzy, dean of the faculty of medicine in the University of Paris. The gold medal of the association, which was instituted last year, is to be awarded to Professor H. Poincaré, who will deliver a lecture during the course of the meeting.

The sixth International Congress of Psychology met at Geneva last week. Among the Americans whose names appear on the program are Professor J. Mark Baldwin, Professor Jacques Loeb, of the University of California; Professor H. S. Jennings, of the Johns Hopkins University; Professor Lightner Witmer, of the University of Pennsylvania; Professor James H. Leuba, of Bryn Mawr College; Professor Max Meyer, of the University of Missouri; Dr. R. M. Ogden, of the University of Tennessee; Professor J. W. Riley, of Vassar College, and Professor R. M. Yerkes, of Harvard University. According to a cablegram to the daily papers the seventh International Congress will meet at Boston, with Professor William James, of Harvard University, as honorary president; Professor J. Mark Baldwin, as president, and Professor E. B. Titchener, of Cornell University, and Professor J. McKeen Cattell, of Columbia University, as vice-presidents.

In recognition of services rendered to the cause of aerial navigation, the French government has conferred the decoration of the Legion of Honor upon Mr. Wilbur Wright, Mr. Orville Wright and M. Farman, and the Officer's Cross of the same order upon Mr. Hart O. Berg and M. Santos Dumont.

The Italian government has decorated Dr. Louis Borsch, an American physician in Paris, with the royal medal of the Ministry of Public Instruction on the recommendation of the committee of the International Congress of Ophthalmology.

Dr. C. Lloyd Morgan, F.R.S., has resigned the office of vice chancellor of the University of Bristol. In accepting the same the council has placed on record its sense of the distinguished services rendered by him to the cause of university education during the twenty-two years of his tenure of office.

Surgeon-General W. L. Gubbins, C.B., M.V.O., deputy director-general of the British Army Medical Service, has been appointed director-general in succession to Surgeon-General Sir A. Keogh, K.C.B.

The State Board of Health of South Carolina has opened a laboratory at Columbia under the direction of Dr. Francis A. Coward.

The New York State Department of Agriculture has been notified that two of its veterinarians, Drs. George R. Martin and John T. Hart, of Goshen, have contracted anthrax, while endeavoring to stamp out the disease among cattle in Orange County.

Professor F. W. Woll, in charge of the department of feed and fertilizer inspection of the College of Agriculture, University of Wisconsin, has left for the west to attend the meeting of the American Association of Agricultural Chemists at Denver from August 26 to 28, and the American Association of Agricultural Colleges and Experiment Stations at Seattle.

Dr. Andrew M. Soule, dean of the Agricultural College of the University of Georgia, and Dr. T. H. McHatton, professor of horticulture, will represent the University of Georgia at the Portland meeting of the Society for the Promotion of Agricultural Science and at the other scientific meetings to be held on the Pacific coast.

Dean H. L. Russell, of the College of Agriculture of the University of Wisconsin, is making a tour of several western states to visit colleges of agriculture and important farming sections, as well as to attend the scientific meetings to be held in connection with the Alaskan-Yukon Exposition. He will address the American Association of Farmers' Institute Workers at Seattle on "The Advisability of holding Demonstration Institutes in the Summer."

Professor Lewis M. Haupt, A.M., Sc.D., addressed the International Congress of Women held at Toronto, Canada, on June 29,

1909, on "Relief Measures in Industrial Crises."

THE following doctorates are reported by *Nature* to have been conferred by the University of London upon internal and external students for the theses mentioned and other papers: Mr. P. Hartley, "On the Nature of the Fat contained in the Liver, Kidney and Heart"; Mr. E. T. Mellor, "The Geology of the Neighborhood of Middelburg, etc."; Mr. J. Stephenson, "Studies on the Aquatic Oligochæta of the Punjab"; Mr. W. Makower, "On the Active Deposit of Radium"; and Mr. H. Stansfield, "The Echelon Spectroscope, its Secondary Action and the Structure of the Green Mercury Line."

IT is stated in the *Nation* that the publication of the complete works of Alessandro Volta is now assured by the action of the Italian government in contributing $3,000 towards the necessary expenses. A committee appointed jointly by the Reale Instituto Lombardo delle Scienze and the Reale Accademia dei Lincei will have charge of this edition, which, it is expected, will consist of five volumes, and be finished within two years.

WE learn from the *Journal* of the American Medical Association that the dedication of the monument in the court of honor of the College of Medicine of Paris to Professor Brouardel, the lamented dean of the college, took place on July 20. The monument, by the sculptor Denys Puech, consists of a stela on which is the marble bust of Brouardel, wearing the insignia of his office. At the foot are two allegorical figures representing hygiene and legal medicine.

DR. ROBERT EDWARD CARTER STEARNS, known for his work on the geographical distribution and variation of mollusca and for other work in natural science, honorary associate in zoology of the U. S. National Museum, has died at Los Angeles, in his eighty-third year.

DR. JOSEPH FREDERICK WHITEAVES, paleontologist and zoologist of the Canadian Geological Survey, died at Ottawa, on August 8, in his seventy-fourth year.

CAPTAIN ENGELSTAD, of the Norwegian Navy, was taking meteorological observations during a thunderstorm, on July 24, when he happened to touch the winch holding the copper wire attached to the kite, which was a thousand yards high, and was struck dead.

THE death was also announced of Professor G. Arth, professor of industrial chemistry in the University of Nancy, and of Dr. Eugen von Gothard, the Hungarian astronomer.

IT is proposed to invite the British Association to meet in Australia in 1913. The University of Melbourne is communicating with the different Australian universities with a view to formulating definite proposals. It is suggested that the invitation should proceed from the commonwealth.

THE trustees of the fund of $1,250,000 left by Henry Barnato to found a hospital in memory of his brother Barney Barnato and his cousin, Woolf Joel, have decided to devote the sum to the building and endowing of a cancer hospital in London.

THE sum of £6,500 will be appropriated by the British government to the Royal Society for the expenses of the aeronautical section of the National Physical Laboratory.

THE daily papers report that a reflecting telescope with a mirror of forty inches has been shipped from Cambridge to Flagstaff Observatory for Mr. Percival Lowell's Observatory. It is designed especially for planetary photography and will first be used in photographing Mars when the planet will be nearest the earth next month.

THE Field Museum of Natural History has secured, for its botanical department, the private herbarium of Dr. J. T. Rothrock, of Pennsylvania. This is the last private herbarium covering the exploration period of North America and contains very full and valuable series of the early collections of the great west, Mexico and Florida. Dr. Rothrock having been the botanist of the survey of the territories and an intimate of Dr. Asa Gray, Dr. Torrey, Dr. Thurber and other early botanists, he was able to secure a large amount of material covering the period dating from 1840 to 1880. The herbarium is especially rich in types and co-types of the plants of western North America.

The twelfth International Congress on Alcoholism, held in London last month, was attended by about 1,400 members, including 400 delegates from abroad.

The Kappa Chapter of the Alpha Chi Sigma Chemical Fraternity was installed at the University of Kansas on May 29. The chapter was installed by Dr. J. H. Mathews, of the University of Wisconsin, and Mr. L. S. Palmer, of the University of Missouri. The following men constitute the charter members of the new chapter: F. P. Brock, A. N. Budd, F. W. Bruckmiller, M. L. Breidenthal, H. N. Calderwood, P. V. Faragher, B. C. Frichot, Chas. Hoffman, H. A. Kohman, P. R. Parmelee, F. W. Padgett, E. R. Weidlein, G. S. Weith and A. J. Weith.

The expedition which is carrying relief supplies to Commander Robert E. Peary left St. John's on August 3. The 88-ton schooner *Jeanie* will take fifty tons of coal and the same amount of stores, which she will land at Etah, Greenland, to supplement the supplies on Peary's steamer *Roosevelt*. The schooner will return as soon as she has discharged her cargo, bringing any despatches Peary may have left.

The first section of the electric funicular railway from Le Fayet to the summit of Mont Blanc was opened to the public on July 25 as far as the Col de Voza (5,495 feet in height). In the morning the first train carried the local French authorities and engineers to the Col, covering the 7½ kilometers in 56 minutes. The whole of the line is constructed in the open. Work will shortly be commenced on the second and most difficult section, about eight kilometers long, to Tête Rousse (10,300 feet).

The Black Hills of South Dakota contain deposits of ores of the rare metals tin, tungsten and tantalum, which have been examined by Frank L. Hess, geologist, of the United States Geological Survey, whose report forms a paper in the Survey's Bulletin 380. The lack of commercially valuable tin deposits in the United States gave especial interest to the discovery of tin ores in the Black Hills. The deposits occur in the northern part of the hills at Tinton and in the southern part near Hill City, Keystone, Oreville and Custer. Mr. Hess sketches the geology of the tin deposits as exposed at the various mines and claims and gives brief accounts of their commercial development. Tungsten deposits occur in the Black Hills at several places, but have been exploited commercially only at Lead, in the central hills. The valuable ore is wolframite. Tungsten is of especial interest and value in connection with its use in tool steel and as a filament in incandescent electric lamps. The tantalum of the Black Hills occurs in the mineral columbite. The known deposits of columbite in the region are described in detail by Mr. Hess. Tantalum is also used in making filaments for incandescent electric lamps.

UNIVERSITY AND EDUCATIONAL NEWS

Kenyon College has recently received $100,000 from Samuel Mather, of Cleveland, the income of which is to be devoted to the increase of salaries of the faculty.

It is announced that the George Peabody College for Teachers will be erected in close proximity to Vanderbilt University and will be affiliated with it.

Dean Harry B. Hutchins has been appointed acting president of the University of Michigan, and will assume his office when President Angell's resignation takes effect on October 1.

Professor F. B. Mumford has been elected dean of the agricultural college in the University of Missouri to succeed Dean J. H. Waters, who has become president of the Kansas Agricultural College.

Dr. John B. Powers has been elected dean of the medical department of Wake Forest University, *vice* Dr. Watson S. Pankin, who resigned to become secretary of the state Board of Health.

The chair of plant pathology recently established in the University of Wisconsin College of Agriculture by legislative action has just been filled by the appointment by the regents of Dr. L. R. Jones, of the University

of Vermont. Professor Jones is a native of Wisconsin, who did his undergraduate work at Ripon College and later took his bachelor's degree at the University of Michigan. He spent three years in graduate study at Michigan and took his doctor's degree in 1894. After receiving his bachelor's degree he was appointed botanist at the University of Vermont, which position he has held continuously since 1889.

SIR ISAMBARD OWEN, principal of Armstrong College, Newcastle-on-Tyne, has been elected vice-chancellor of the University of Bristol and Professor J. Michell Clarke pro-vice-chancellor.

DISCUSSION AND CORRESPONDENCE

AMERICAN MEN OF SCIENCE AND THE QUESTION OF HEREDITY

TO THE EDITOR OF SCIENCE: The statement of Mr. W. J. Spillman in your issue of February 12 regarding the superiority of country-bred boys, which I contraverted in your issue of April 9 by an appeal to "Who's Who in America," led me to examine the data which Professor Cattell collected for his "Statistical Study of American Men of Science."[1]

I pointed out in my former letter that Professor Cattell found a marked superiority for cities over the rural districts in the production of men of scientific merit, while my own investigation shows that this may be extended to include leadership in various phases of activity.

Professor Cattell, moreover, discusses his data in relation to their bearing on the question of the inheritance of scientific aptitude. I should like in this letter to make a few points of criticism concerning his interpretation of his results. Although he calls attention to the ambiguity and insufficiency of certain of his figures, he nevertheless gives the impression that he considers his results in general an argument against heredity. For instance, he states (page 734) that

> The inequality in the production of scientific men in different parts of the country seems to be a forcible argument against the view of Dr. Galton and Professor Pearson that scientific performance is almost exclusively due to heredity.[2] It is unlikely that there are such differences in family stocks as would lead one part of the country to produce a hundred times as many scientific men as other parts. [This is one of the points I wish to criticize].

Also on page 735 Professor Cattell writes:

> The fact that there is not a significant difference in the average standing of scientific men born in different regions of the country tends to support the conclusion that scientific performance is mainly due to environment rather than to innate aptitude. If the fact that Massachusetts has produced relatively to its population four times as many scientific men as Pennsylvania and fifty times as many as the southern states were due to a superior stock, then we should expect that the average standing of its scientific men would be higher than elsewhere; but this is not the case. [The above sentence expresses the second point that I should like here to criticize.] Like most arguments intended to disentangle the complex factors "nature and nurture," this however is not conclusive. If scientific ability were innate, each tending to reach his level in spite of environment, then a potentially great man of science would become such wherever born, and we might expect a favorable environment to produce mediocre men, but not great men. But this argument is answered by the small number of scientific men from certain regions of the country. Differences in stock can scarcely be great enough to account for this; it seems to be due to circumstance. A further analysis of the curves of distribution might throw light on the problem. Thus it might be that the men of greatest genius were independent of the environment, while men of fair average performance were produced by it. Examples might be given in favor of this view, but I can not see that it is supported by the forms of the curves of distribution. I hope at some time to take up the question from a study of individual cases, but I have not as yet the data at hand. My general impression is that certain aptitudes, as for mathematics and music, are mainly innate, and

[1] SCIENCE, N. S., Vol. XXIV., No. 623, December 7, 1907.

[2] I should like to ask in passing for the exact references to the writings of these gentlemen in which they have stated that *scientific performance* is almost exclusively due to heredity, or words to this effect.

that kinds of character and degrees of ability are mainly innate, but that the direction of the performance is mainly due to circumstances, and that the environment imposes a veto on any performance not congenial to it.

Thus while Professor Cattell certainly is not dogmatic, there are two points which to him indicate that heredity can not be the chief cause of scientific performance. These are, first, the great disproportion in the birth rate of scientific men in some regions as compared with others, and, second, the failure of Massachusetts to have produced men of high average standing.

That one part of the country should produce a hundred times as many scientific men as another, or even fifty times as many, seems extraordinary from any point of view, and perhaps to some it would seem as unlikely from the standpoint of environment as from any other; but the point I wish to bring out is that the more probable significant disproportion lies a great deal lower than this. His figures, on page 733, show that the hundred-to-one ratio applies only where the data are very meager numerically, so that the probable error is necessarily large. In order to increase our totals and decrease our probable error, it is better to average a little belt of the southern states all of which show a very low ratio. Thus we get a close idea of the contrast between Massachusetts and a typical low-ratio southern state. The section comprised of the states North Carolina, South Carolina, Georgia, Tennessee, Alabama, Mississippi, Louisiana and Texas brings in 26 scientific men against 134 from Massachusetts, with an average ratio of 3.75 per million for the south against 108.8 per million for Massachusetts. Thus we find that Massachusetts has produced nearer to twenty-nine times as many, instead of one hundred times, or fifty times as many, which were the ratios mentioned by Professor Cattell.

This is still a wide disproportion and one that undoubtedly means something, but I personally should feel that we were getting closer to its real significance if we nearly double the ratio for all the southern states, on account of the negro population, and make it a question of northern whites against southern whites. By such a method we get a more homogeneous mass of material, a desirability in biometrical work.

According to Professor Cattell "the negro may have a racial disqualification [for scientific achievement], but even this is not proved." It is of course impossible to absolutely disprove such a disqualification, but the same might be said for any organisms, no matter how low in the scale of mental evolution. The fact that millions of negroes have been to school and yet one would scarcely know where to find a single example of a negro scientist suggests strongly an experiment of millions of trials and millions of failures, which gives us some idea of its probability. Is not probability all that we can get out of statistics, anyway? If we adopt the method of leaving the negroes out of the ratios, we find that Massachusetts has produced more probably about seventeen times as many scientific men as a low-ratio southern state. That is, the ratio for the average southern state is raised from 3.75 per million to 6.54 per million, while the ratio for Massachusetts is merely raised from 108.8 to 109.7 per million.

There were 27,001,491 whites in the United States according to the census of 1860, and 1,221,464 of these lived in Massachusetts. Thus this state might have been expected to have produced 4.52 per cent. of the men of science in Professor Cattell's list. As a matter of fact it has produced 15.4 per cent., or 3.4 times the expected.

Now, the interesting question arises—Is this discrepancy more than might be reasonably accounted for by differences in stock? I know of no way of exactly answering this question, but I should like to make record here of some investigations I have carried on which seem to show that the results of Professor Cattell may very likely be entirely due to differences in stock.

First, let us see how Massachusetts stands when general intellectual achievement is taken into consideration instead of special merit in science alone. A little computation from the birth statistics in the latest issue of "Who's Who in America" shows that taking the cen-

sus of 1860 as our basis, Massachusetts has produced 11.6 per cent. of the total, or 2.6 times the expected. This is not as great a disproportion as one finds in Professor Cattell's statistics, but it is a high one. Massachusetts leads all other states, and is easily ten to thirty times ahead of some states. Furthermore, it is almost certain that the standard represented by Professor Cattell's list of one thousand is somewhat higher than that represented by admission into "Who's Who in America." This I assume to be the case because I have calculated that there are about two thousand names of scientific men in the latter volume who would be included under the various specialties tabulated in Professor Cattell's study.

One of the chief reasons which this investigator gives for doubting that his results are due to differences in stock is the fact that Massachusetts has not produced relatively more men of the highest grades in science. His figures are sixty in the total for the superior grades (I.–V.) and seventy-four in the less superior grades (VI.–X.). This would doubtless be a very strong argument in just the direction which he has indicated if it should be substantiated by further statistics; but I have several reasons for thinking that as the figures here stand, this unexpected ratio in the single case of Massachusetts is caused by the smallness of the figures themselves. I have arranged the states in two groups, so that one group, Massachusetts, Colorado, Connecticut, Washington, Nebraska, Kansas, Vermont, New York, Maine and New Hampshire, contains half the total number of scientists, and all the superior ratio states in the order of their superiority. Massachusetts then appears to be an exception, for the group as a whole *does* average more names in the I.–V. grades than in the VI.–X. The difference is, however, only a slight one, being 227 against 205. This is outside of, though not twice, the probable error 7, so the difference is suggestive if not significant, and the total number of cases is at the same time proved not great enough for a final conclusion. If, however, the same ratio were maintained for a greater mass of data, it would soon become significant as showing a higher average standing for scientists born in the high-ratio states. Thus if the totals were all raised a hundredfold, since the probable error would be increased only tenfold, the difference would then be fifteen times the probable error, and the chances against mere hazard's explaining the result would be enormous.

It may be that the actual intellectual differences between those in the I.–V. and those in the VI.–X. grades are really not very great after all. I fancy there are many more names of older men in the I.–V. or higher grades, who with the same amount of brains as many younger men in the lower grades have had a longer time in which to gain a reputation. Even so, the I.–V. grades should average somewhat above the VI.–X., in real ability, though it is easy to see that something of the true difference in actual merit between the two groups is lost as soon as differences in age-average exist between them. Such a force would work mathematically in two opposed directions and cause confusion. Without the age-averages of the two groups, it is impossible to say how this factor might affect the results.

I thought it would be interesting to know if the ratio of scientific men born in Massachusetts would be as high if all examples be taken into the discussion, using the entire book "American Men of Science" instead of the thousand selected and presumably superior group used by Professor Cattell. I have therefore had a count made of the entire number in this book of 4,000 names. There are 436 reported as born in Massachusetts. The exact total number of names is unfortunately not printed in the book, but is given as more than 4,000. Taking the number even as low as 4,000 and assuming that 87 per cent. were born in this country, as is the case with the 1,000 superior ones, the per cent. born in Massachusetts is reduced from 15.4, found for the superior group, to 12.5 for scientists of all degrees of merit. Thus there is something to show that Massachusetts *has* produced relatively more men of science of the superior sort.

Turning now from special aptitude in science to general mental eminence, as shown in

all fields of activity, let us see if there are any facts to indicate that the ratio of 11.6 per cent. for Massachusetts birth, or 2.6 times the expected, found for "Who's Who in America" is any higher if one takes a much more select group of names. I think of only two such lists already in existence. Both possess decided objective value. One is comprised of the names of the thirty Americans included in Professor Cattell's "Statistical Study of Eminent Men." The other is the roll of thirty-seven in the "Hall of Fame."

I find that out of the thirty in Professor Cattell's list, eleven were born in Massachusetts, or 36.6 per cent. I have gone back to the first census of 1790 as being approximate to the time of their birth, on which basis there should have been about 12 per cent., or the ratio is about three times the expected. In the "Hall of Fame" I find fifteen born in Massachusetts, or 40.6 per cent. against about 12 per cent. expected. It will be observed that both these ratios are higher than the 2.6 times the expected found for the names in "Who's Who in America."

If the greatest eminence is more independent of environment than the lesser forms, why then should not heredity and environment working together produce a higher ratio for Massachusetts when the lesser standard is taken than when only the truly remarkable are concerned? If these illustrious characters are born such and not made, we get some suggestion of how really superior the stock of Massachusetts must be as compared with any other part of the country. It can be seen from the foot-note[3] that with the exception of Virginia the entire country to the south of New York has done almost nothing in producing our greatest Americans. If Massachusetts has given birth to seventeen times as many men of especial scientific merit as some other sections of the country, she has at the same time produced more nearly fifty or a hundred times as many men, if the highest ranks of eminence be alone considered.

There still remains, I think, something from the various figures that I have so far analyzed to indicate that New England, and especially Massachusetts, shows a slightly higher aptitude for science than for general intellectual performance taken as a whole. But is this more than might be expected from differences traceable to selection of stocks, to differences in types of mind in those who emigrated to the various colonies? I can not, of course, answer this question. It is, however, the general impression that the south was peopled, aside from the negroes, by two classes, the gentry and the poor whites. The descendants of the cavaliers were people of refinement and polish, rather inclined to hospitality and good living, with interests of a practical, legal and political sort, than to the serious contemplation which is supposed to have characterized the puritans. As for the poor whites of the south, they are certainly not the stock from which one would expect scientists.

The factor "density of population" which Professor Cattell mentions first under his "main factors in producing scientific and other forms of intellectual performance" deserves, I think, a slight criticism. In the first place we do not find the center for the birth of scientific men (which is around Massachusetts or Connecticut) at all coinciding with the general population center, which in 1860 was twenty miles south of Chillicothe, Ohio. Moreover, a list of the states according to density of population at that time, gives us, District of Columbia, Rhode Island, Massachusetts, Connecticut, New Jersey, New York, Maryland, Pennsylvania, Ohio, Delaware as the ten leading

[3] "*Eminent Men*": Massachusetts, 10; Virginia, 7; New York, 3; Ohio, 2; Rhode Island, Maine, New Hampshire, New Jersey, Pennsylvania, Kentucky, Tennessee and Louisiana, each 1; Vermont, Connecticut, Delaware, Maryland, North Carolina, South Carolina and Georgia, none.

"*Hall of Fame*": Massachusetts, 14; Virginia, 6; New York, 4; Connecticut, 3; Rhode Island, 2; Ohio, 2; Maine, New Hampshire, Pennsylvania, Kentucky, Tennessee and Louisiana, each 1; Vermont, Delaware, Maryland, North Carolina, South Carolina and Georgia, none.

It can be seen that, with the exception of Connecticut, the proportionate agreement between these two lists, formed by entirely different methods, is almost perfect.

states for density. One finds in this list only three of Professor Cattell's ten leading states. that is, the ten leading states which gave birth to half his total number of scientists. Should the problem be worked out carefully there would be found, I have no doubt, some correlation between the birth of superior men and density of population. Considering the great over-proportion which cities are known to produce, I can not see how it can fail to be so, but it appears on first sight that it will be significant to one who might wish to predict a result, not so much to know that there is a center of density as to know which particular center it is. The group of states, New Jersey, Pennsylvania, Delaware, Maryland and Virginia, are not usually thought of as lacking in "wealth, opportunity, institutions and social traditions," and yet this territory is distinctly behind New England in the production of scientific men, and only as good as the great western and north-central divisions, which were largely peopled by New England stock.

One might ask why the latter districts, if formed from the stock of New England, have not done equally as well as New England itself. The answer from the standpoint of heredity would be that distinguished scientific men come in great proportion from families of the professional and upper classes[4] and that these families had, prior to 1860, generally stayed at home in New England. The great western migration of the last century must have produced a kind of natural selection. Very likely the west has been the gainer and New England the loser, from the standpoint of vigor, energy and ambition. But it seems fair to suppose that while the better of the middle classes might have joined the emigrant trains, the intellectual aristocracy did not.

To distinguish between heredity and environment is at best a difficult problem, and the statistics here analyzed give, of course, no final answer. All I wish to say is, that there is nothing in these birth ratios to shake ones belief in the extreme importance of heredity,[5] or even to show that environment is the main cause of the "direction of the performance" itself.

[4] Conf. Galton, "English Men of Science," London, 1874; Galton and Schuster, "Noteworthy Families," London, 1906; Candolle, "Histoire des sciences et des savants," Genève, 1873; Ellis, "A Study of British Genius," London, 1904.

[5] For a list of researches which lead to this belief, see Science, April 9, 1909, page 579.

Frederick Adams Woods

Brookline, Mass.,
April 15, 1909

Dr. Woods permits me to add some comments to his discussion. The adjacent states of Massachusetts and Connecticut, with a population of 1,691,213 in 1860, have produced 174 of our thousand leading scientific men, whereas the adjacent states of Georgia, Florida, Alabama, Mississippi and Louisiana, with a population of 3,661,218 in 1860, have produced but seven. The one region has produced per thousand of its population more than fifty times as many scientific men as the other.[1] This great difference, it appears, is more probably due to social conditions, educa-

[1] This disparity will be reduced to nearly half if the negroes are excluded. The fact that the southern whites are nearer to the negroes in their scientific productivity than to New Englanders, is in favor of scientific performance being due to social environment rather than to stock. A similar argument may be drawn from the fact, if it proves to be a fact, that mulattoes resemble blacks more than whites in their scientific productivity. It is, however, also the case that if the southern whites and the negroes were given equally an environment favorable to scientific work, the whites might far surpass the negroes. The question as to whether scientific productivity is mainly due to heredity or environment is not one that can be answered without qualifications and explanations. If environment is the same, differences are due to heredity; if heredity is the same, differences are due to environment. As President Lowell has recently remarked, we have a better chance of rearing eaglets from eagles' eggs placed under a hen than from hens' eggs placed in an eagle's nest. But it is also true that we have a better chance of raising tame eaglets in a chicken coop than in an eyrie. The difference between a man uninterested in science and a scientific man is not that between a chicken and an eagle, but that between an untrained chicken and a trick

tional institutions and opportunities for a career than to stock, and is thus evidence in favor of scientific productivity being in the main due to opportunity rather than to heredity. It is probable that if the 174 babies born in New England who became leading scientific men had been exchanged with babies born in the south, the scientific productivity of New England would not in that generation have been materially decreased, nor the scientific productivity of the south have been greatly increased. It is certain that there would not have been 174 leading scientific men from the extreme southern states and only seven from Massachusetts and Connecticut. If the stock of the southern states remains undiluted, it may, as social conditions change, produce even more scientific men per thousand of its population than New England has hitherto produced. Japan had no scientific men a generation ago and China has none now, but it may be that in a few years their contributions to science will rival ours.

The second point discussed by Dr. Woods is my qualified inference that the fact that those regions which have produced more scientific men have not produced men of higher average performance is against the theory that scientific productivity is mainly due to heredity. Dr. Woods says that this would doubtless be a very strong argument if it should be substantiated by further statistics. His discussion of my statistics does not seem to alter the interpretation put on them. He, however, brings forward new data of interest, which show that the scientific men produced by Massachusetts are slightly above the average and that Massachusetts has produced far more than its share of men of unusual eminence. These facts do not, however, affect my argument. It would be expected that the educational advantages and opportunities for research in Massachusetts would give its scientific men a higher average standing than those elsewhere, even though their native ability were the same. It is surprising that this does not show at all in the 1,000 leading men of science and but slightly in the 4,131 included in the "Biographical Directory." In the case of men of exceptional genius, I agree with Dr. Woods that they can not be regarded as the product of their environment. But it may interpose a veto on their performances. There may be "mute inglorious" Emersons in southern churchyards. Lincoln was as great a writer as Emerson; but it is in a way a chance that he made his Gettysburg speech. It is likely, but not proved, that one region of this country or one of its racial stocks has more potential men of genius than another.

cock. Some cockerells can be trained better than others, but there are innumerable cockerells that might be trained and are not.

While views such as those of Dr. Galton when he says "The impression that all this evidence leaves on the mind is one of some wonder whether nurture can do anything at all" or of Professor Pearson when he says "We inherit our parents' tempers, our parents' conscientiousness, shyness and ability, even [to the same extent] as we inherit their stature, forearm and span," seem to be extreme, I hold, as stated in the paper quoted by Dr. Woods, that "kinds of character and degrees of ability are mainly innate." But I believe also that there is in this country a vast amount of the character and ability required for scientific productivity which is not used for this purpose, and that the quantity, though not the quality, of our scientific work could be increased to almost any extent. What a man can do is prescribed by heredity; what he does is determined by circumstance.

J. McKeen Cattell

GENERA WITHOUT SPECIES

The views on genera without species held by Dr. J. A. Allen, as expressed in Science, June 11, 1909, may possibly be shared by a few entomologists interested in restricted groups and by many students of higher forms of life, such as birds and animals. It is not remarkable that an ornithologist or mammalogist, whose entire number of subjects scarcely equals that of the species of a single family of some orders of insects, should hold that personal judgment should enter into the solving of this important problem. It is the man

who is concerned with the hundreds of thousands of names rather than he who deals with the thousands that sees most clearly the hopelessness of gaining stability by methods where personal opinion is given full sway. Dr. Allen attributes the remarkable unanimity of opinion of those opposed to his views to inexperience or ignorance of the subject. If the worthy doctor himself was more experienced in the fields of entomology or botany, where the forms are countless as compared with animals or birds, he might be less positive in his position on this question. It may not be absurd to state that an ornithological genus based on an unnamed woodpecker with three toes can not be mistaken because but one such bird was known. But would it seem so plausible to state that a genus of insects based on an unnamed specimen of parasitic hymenoptera, or a minute fly, with a certain vein of the wing forked before the middle was unmistakable because but one such species was known while many thousands of such little creatures are flying undescribed about us?

It is true that this question is not definitely covered by the International Code, but certain statements do have a bearing on the subject. On page 11 of the code the generic and specific name is likened to the family and individual names of persons. Now who can conceive of a family of Smiths without a John or a Jane in it? Would it not seem silly to have a name Johnson before any one was born to bear it? Getting back to genera, what is a genus? "An aggregation of one or more species" would seem to be a good definition. If such a definition was accepted it would certainly invalidate the genus without species, so I presume Dr. Allen has another definition. Not knowing what it is, I can not discuss it. The code does not define the genus. However, it is now quite universally agreed that a genus should have a type designated. Article 30 of the code, paragraph 2, says: ". . . nor can a species be selected as type which was not originally included in the genus. . . ." This being true, how can we get a type for a genus where there were no species originally included? In the amendments to the code, published in SCIENCE for October 8, 1907, is the following: "The commission is unanimously of the opinion that a *name*, in the sense of the code, refers to the designation by which the actual objects are known." Now a genus without a species has no object; it is a name applied to a conception, not to an object and can therefore have no place in systematic nomenclature.[1]

No one, I think, claims infallibility for the international code; but it is certainly not to the best interest of nomenclatorial stability to knowingly violate its recommendations. An able board of chosen nomenclaturists has passed on and sanctioned these rules and formulated them into an accessible code, and it should be incumbent upon systematists to comply with them so far as possible. There are enough questions not covered by the code to furnish constant contention without bringing up problems that are capable of being disposed of under the rules already formulated. That which is best in one group may not be the best for another, but for the sake of uniformity and in the hope of future stability let us accept the dictum of the International Zoological Congress and follow the code.

A. N. CAUDELL

U. S. NATIONAL MUSEUM

A NOTE ON UROPHLYCTIS ALFALFÆ (V. LAGERH.) P. MAGN. IN CALIFORNIA

A CROWN gall of alfalfa (*Medicago sativa*) which occurs in Europe, but which, so far as known by the writer, has not before been noted in this country, has recently come to our attention in California.

The disease was first observed in Ecuador in 1892 by Lagerheim, who placed the parasitic fungus causing it in the genus *Cladochytrium*. In 1902 it was found in Alsace, Germany, by Magnus, who transferred the organism to the genus *Urophlyctis*. It has since been observed in other localities on the continent, where it has done considerable damage.

The galls are usually very numerous at the

[1] *Nomen nudum* does not seem inappropriate in this connection.

crown of the affected plant, and frequently occur an inch or two up on the stem. Though usually small, or in an irregular divided mass, they may be round and unbroken, and three or four inches in diameter. The interior of the gall is composed of small, irregular cavities in the hypertrophied tissue, the chambers being filled with masses of brown resting spores about forty micro-millimeters in diameter.

A more detailed account of the disease as it occurs in California will be published shortly.

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June 2, 1909

THE WEST INDIAN SEAL AT THE AQUARIUM

THE New York Aquarium received on June 14, 1909, an adult male and three yearling specimens of the rare West Indian seal (*Monachus tropicalis*). One of the latter was in a weak condition and died the day after arrival. The others are apparently doing well. The specimens were procured from a dealer in live turtles at Progresso, Yucutan, who reported the species as a great rarity. They were presumably captured at either the Triangle or the Alacran islets in the Gulf of Campeachy, the only known resorts of the species at the present time, so far as I am aware.

They are probably the only specimens of this nearly extinct species now living in captivity. Its original range included the coasts of Cuba, Haiti, Jamaica and the Bahamas. For the last half century it has apparently been restricted to the islands of Yucatan. It was well known to the sailors of Columbus and was later the basis of a seal fishery.

In SCIENCE for April 13, 1906, I recorded the killing of a specimen at Key West, Florida, on February 26, 1906. The species had not been seen in Florida for about thirty years.

The New York Aquarium received two specimens in 1897, one of which lived in the aquarium until 1903. Both of these animals had the singular habit of filling their cheeks with water and blowing it suddenly and with considerable force into the faces of visitors leaning over the pool. It will be interesting to discover whether the specimens now in the building develop this trick, which for years excited the amusement, and sometimes the wrath, of visitors. Unlike the other Phocidæ kept on exhibition here, *Monachus* is noisy, the young often roaring harshly.

C. H. TOWNSEND
NEW YORK AQUARIUM

SCIENTIFIC BOOKS

Scientific Papers. By SIR GEORGE HOWARD DARWIN. Cambridge, at the University Press. Vol. I., pp. xiv + 459; Vol. II., pp. xvi + 514.

The task of the reviewer who undertakes the consideration of a republication of matter which has been for some years before the public in an accessible form, is not particularly easy. He may, of course, take refuge in statements more or less detailed of the contents of the volumes before him and say little more than the intelligent reader can glean by turning over the pages himself. Or he may write a few paragraphs on the history of the subjects treated, showing the author's relation thereto and his place in their development. More often he seizes a few points of a controversial character and in discussing them simply adds to the literature of the subject. No one of these methods appears to be satisfactory from the point of view of the reader. Brief reviews not intended for serious study, although they may be the result of such study, should, it seems, be written chiefly to save time and labor for the reader and perhaps to express the opinions of the reviewer, since in scientific journals at least the editorial "we" has ceased to be even a disguised fiction. Such reviews thus necessarily pass into the class of ephemeral productions which may have value at the time of publication, but which only add to the labor of future students if they contain matter belonging properly to the development of the subject.

If a writer accepts this view and takes to the criticism of matters beyond the mechanical detail of form and arrangement, an estimate of the writer and his work, however dangerous, is necessarily the main topic. After all, such criticism is merely a single opinion as to whether the attitude of the scholar towards his

work, his methods and his manner should or should not be recommended for the guidance of those who wish to aim at similar achievements. This at any rate is true with respect to works like the one before us, their intrinsic value not being open to question. In reading such productions, especially in collected form, one necessarily forms a picture, conscious or otherwise, of the author's mind quite apart from any personal acquaintance, and it may be that no apology is needed for recording such an impression and for pointing out some features of the author's work and methods which appear to the present reviewer to be of high value in the study of applied mathematics.

The lines on which Sir George Darwin has so far published memoirs have been mainly laid in the subject of hydromechanics and its mathematical associate, the theory of elastic solids. These have been applied to masses in bulk and subject to the Newtonian law of gravitation with applications to present-day astronomical and geophysical problems and to theories of cosmogony on the basis of a continuous evolution of planetary and satellite systems. These problems, whether we consider them from the mathematical or physical side, are certainly the most difficult of all the studies in celestial mechanics which have received attention in the past. It is true that there are many ideal problems which admit of moderately simple treatment, but the majority of these can not be considered even as a first approximation to the real problems presented by the observed phenomena. One notices throughout Professor Darwin's work that he rarely takes up an ideal problem without having in view the ultimate answer to some physical question. Almost the single exception to this is his paper on periodic orbits, and the possible complications of solar systems other than that to which we belong makes this exception a doubtful one.

The difficulties are increased when it is desired either to interpret the mathematical results in terms of simple and easily understood phenomena or to put them into such forms that numerical values may be substituted directly for the symbols. These objects Professor Darwin appears to have continually in view. He is rarely contented with the mathematical solution of a set of differential equations, however intricate or interesting the solution may be from the symbolic point of view, but searches to find the physical explanation or analogy which will enable him and the reader to follow without great mental effort the various sequences of events which must result from the formulæ obtained.

One notices too the wide range between what are popularly called "practical results" and speculative theory. On the one hand, we have his work on tidal prediction with all its associated problems, solutions of which are necessary or valuable in the concerns of daily life, and on the other hand, the highly speculative (I use his own term) investigations into the past history of the satellites and planets which form our solar system. In the former case the object in view was chiefly the discovery of methods for obtaining the times and heights of the tides at any place without excessive labor, that is, in these days when numerical computation is a recognized profession, at a cost which is within the means of those who desire the results. In such work the mathematical developments have generally a minor interest: they are considered to be merely tools for the fashioning of the machine under construction. At the other end of the scale is the work of purely scientific interest related to problems of cosmogony, chiefly those of the past, in which the mathematical developments frequently have an interest of their own and give rise to problems in pure mathematics which may be entirely separated from any physical considerations.

In using the term "highly speculative" it is well to distinguish between work of the character of Darwin's theory of the lunar evolution based on known physical data clearly stated, developed with rigid mathematical accuracy and with careful attention to any factors which may modify the results, and the ill-defined guesses developed, it may be, from some isolated principle which not infrequently appear as proofs of the correctness or falsity of some new or old idea. In the matter of cosmogony this has been especially obvious of

late years, and nowhere more so than in the attempts to trace back astronomical systems to an earlier state on the theory of a general evolution of the arrangement of matter. One can not read Sir George Darwin's work in this line without being impressed with the caution which he continually exercises and wishes to impress on the reader for any results, especially those which are numerical, that he may print. It is interesting to learn his own opinion of the outcome of the controversies which have sprung from the theories set forth years ago in his papers, and I can not do better than to quote his estimate as given in the preface to Volume II. In referring to the papers on Tidal Friction and Cosmogony, which fill this volume, he says:

For the astronomer who is interested in cosmogony the important point is the degree of applicability of the theory as a whole to celestial evolution. To me it seems that the theory has rather gained than lost in the esteem of men of science during the last twenty-five years, and I observe that several writers are disposed to accept it as an established acquisition to our knowledge of cosmogony.

Undue weight has sometimes been laid on the exact numerical values assigned for defining the primitive configuration of the earth and moon. In so speculative a matter close accuracy is unattainable, for a different theory of frictionally retarded tides would inevitably lead to a slight difference in the conclusion; moreover, such a real cause as the secular increase in the masses of the earth and moon through the accumulation of meteoric dust, and possibly other causes are left out of consideration.

The exact nature of the process by which the moon was detached from the earth must remain even more speculative. I suggested that the fission of the primitive planet may have been brought about by the synchronism of the solar tide with the period of the fundamental free oscillation of the planet, and the suggestion has received a degree of attention which I never anticipated. It may be that we shall never attain to a higher degree of certainty in these obscure questions than we now possess, but I would maintain that we may now hold with confidence that the moon originated by a process of fission from the primitive planet, that at first she revolved in an orbit close to the present surface of the earth, and that tidal friction has been the principal agent which transformed the system to its present configuration.

After some remarks on the difficulties in the way of the acceptance of the theory due to the time element and the probable date of solidification he refers to the arguments of Lord Kelvin based on temperature gradients and points out how the possible effects of radioactivity and the "colossal internal energy resident in the atom" may tend to nullify any estimates based on temperature alone. Summing up, he adds:

It is very improbable that tidal friction has been the dominant cause of change in any of the other planetary sub-systems or in the solar system itself. Yet it seems to throw light on the distribution of the satellites amongst the several planets. It explains the identity of the rotation of the moon with her orbital motion, as was long ago pointed out by Kant and Laplace, and it tends to confirm the correctness of the observations according to which Venus always presents the same face to the sun.

The arrangement adopted for the order of the papers is not entirely chronological. Professor Darwin remarks that in the case of his own work, his papers fall into a few well-defined groups and that this fact furnished him with the opportunity to place together those papers which deal with particular subjects. As a result of this arrangement the first part of Volume I. consists of what is practically a treatise on the tides and tidal prediction, the second part containing two papers on the lunar disturbance of gravity, while the whole of Volume II. is devoted, as stated above, to tidal friction and cosmogony. Appended to each volume is a chronological list of all his papers with references to the volumes in which they are or will be contained.

The collection will thus be something more than a reprint. In general the reproduction is literal, but here and there are notes pointing out an occasional error or giving a reference to later work by himself or others which has tended to modify the earlier conclusions or to fill gaps which had existed. One sometimes wishes that these notes had been more frequent so as to include references and perhaps

brief accounts of later work. However, for the greater part of these two volumes, the article Bewegung der Hydrosphäre in Vol. VI., 1, 6, of the "Encyklopädie der mathematischen Wissenschaften," by Darwin and Hough, will be found to supply these needs. This article is to be reproduced, it is to be hoped in English, in Volume IV. of the "Scientific Papers."

I may mention one point in conclusion in connection with Sir George Darwin's presentation of his work which earns the gratitude of those who are unable from want of time or training to read his papers in detail as well as of those who do such reading but wish to get a general view of his processes and results as a first step. In the summaries to the longer memoirs he gives not only the general conclusions at which he has arrived, but also a brief account, without symbols, of the hypotheses on which the arguments are based, the methods employed and the general course of the mathematical procedure. These summaries have made the task of following his work very much less difficult and have doubtless contributed in some measure to the early acceptance of the theories which he has set forth.

The printing done by the Cambridge University Press is too well known to need comment here. The size of the volume adopted is the modern compromise between convenience for the printing of long formulæ and suitability of size for easy handling and reading, namely, the royal octavo between one and two inches thick.

ERNEST W. BROWN

The Problem of Age, Growth and Death: A Study of Cytomorphosis based on Lectures at the Lowell Institute, March, 1907. By CHARLES SEDGWICK MINOT. New York and London, G. P. Putnam's Sons. 1908. Pp. 280; good index.

Many biologists, and with them a wide circle of people who are intelligently interested in fundamental problems of life, have followed Professor Minot's researches in this field with keen interest for thirty years past, and will be glad to have the many scattered papers collected in book form and brought down to date. The purpose of the book is stated in the elaborate "introductory letter," which is addressed to Senator Mosso, to whom the work is inscribed. It is a study of "increase in the amount of protoplasm" as compared with the bulk of nucleus in the cells of the growing animal.

The first lecture deals with the process of growing old as seen in the body as a whole; and while the familiar data are exceptionally well presented, it calls for no special review. The second lecture, "Cytomorphosis—the Cellular Changes of Age," carries a somewhat parallel line of thought through the microscopical changes in the cells and tissues from the germinal to the senescent condition. Here we learn, in connection with appropriate figures in the text, about the "cytomorphic cycles" of different cells, connective tissue, nerve, muscle, gland and blood; and of the death and old age of cells in atrophy or degenerations of various kinds. As cells differentiate from the germinal to the adult form they become fitted to perform specialized functions, but lose the germinal power of growth and regeneration. Thus death is continually present in life, and may be even more active in the embryo, as, in the rapid whirl of cell-life, whole organs form and vanish, than during any other period of life. In fact one of the main theses is that: "The period of most rapid decline is youth; the period of slowest decline is old age."

The third lecture—"The Rate of Growth," gives the results of the author's extensive studies on the growth of guinea-pigs, rabbits and fowls and correlates them with those of Quetelet, Donaldson, Muhlmann and Thoma for man. The facts are presented with great precision in text, table, series of figures of embryos and by most striking charts and curves, growth being expressed, in the main, in percentage increments. The chief result is that power to grow is greatest in the germ and decreases rapidly with age. For example, using Richard Hertwig's calculation, the fertilized human ovum is 0.004 of a cubic millimeter; the child at birth from 3 to 4,000,000 cubic millimeters, which shows an increase of one billion times the original mass during gestation. From birth on to twenty years of

age the increase is only as 1 to 16. Thus Dr. Minot figures that: "Over 98 per cent. of the original growth power of the rabbit or chick has been lost at the time of birth or hatching," respectively, and the same thing is equally true of man. "We start out at birth certainly with less than two per cent. of the original growth power with which we are endowed."

While this conclusion is announced as most remarkable, and possibly it may seem so from the standpoint of an anatomist, the physiologist, and it would seem the biologist as well, would welcome it as a sign of efficiency. The quicker the machine can be built, adjusted and set to do the work designed for it the better. So the illustration which Dr. Minot chooses seems inapt. He says:

But as that accumulation (of protoplasm) goes on, our body seems to become, as it were, tired. We may compare it to a man building a wall. He begins at first with great energy, full of vigor; the wall goes up rapidly; and as the labor continues fatigue comes into play. Moreover, the wall grows higher, and it takes more effort and time to carry the material up to its top, and to continue to raise its height, and so, as the wall grows higher and higher, it grows more slowly, and ever more slowly, because the obstacles to be overcome have increased with the very height of the wall itself. So it seems with the increase of the organism; with the increase of our development, the obstacles to our growth increase.

This statement of the case seems to be crucial to Dr. Minot's conception of the significance of growth and a biologist may be pardoned for wondering whether, even with so inapt a figure, the builder might not finish his wall and then use it, without fatigue; or whether, at certain stages in the work, he might stop building and begin chiseling inscriptions or ornaments upon it without fatigue. In reality we have, instead of a man building a wall of no definite height and for no definite use, an inventor building a machine, every dimension of which is fixed and subordinated to a definite purpose. It would be suicidal to go on "growing," building the machine larger after it is completed, and it is entirely conceivable biologically that the inventor might finish his machine and run it until it wears out or breaks down without any of the slowing down or growing tired of which our author makes so much. The wall simile must recall to the reader, the building of a certain tower, the completion of which was interdicted.

Special function presupposes specialized protoplasm, and we are next led to consider "Differentiation and Rejuvenation." The chief point in this field is that "*Rejuvenation is accomplished chiefly by the segmentation of the ovum.*" That is, in segmentation the cells are greatly diminished in size, with great increase in the amount of nucleus in proportion to protoplasm; and thus segmentation brings about the production of young cells.

The entomorphic cycle is thus again started, and as the cells differentiate and grow old it becomes impossible for them to become young again. The evidence is marshaled to prove that there is no "retrogressive development—Entdifferenzirung," as Driesch and Korschelt maintain. Instead of this certain cells retain the embryonic condition in all organs and tissues capable of regeneration and all such new growth is accomplished by proliferation of these young cells. Furthermore, the reproductive cells are early shunted out of the cytomorphic cycle of the individual, and, retaining the character of undifferentiated germ cells, are able to rejuvenate successive generations—the familiar "germ-plasm theory" commonly accredited to Wiesmann, but which Dr. Minot traces to Nussbaum. A new point of fundamental interest is raised in this connection, viz., the differentiation of nuclei; but while this is claimed we are disappointed that neither the figures nor the text makes it at all clear in exactly what changes this differentiation consists.

The final lecture on "The Four Laws of Age" gives the author's conclusion of the whole matter in categorical form.

First, rejuvenation depends on the increase of the nuclei.

Second, senescence depends on the increase of the protoplasm, and on the differentiation of the cells.

Third, the rate of growth depends on the degree of senescence.

Fourth, senescence is at its maximum in the very young stages, and the rate of senescence diminishes with age.

As the corollary from these, we have this—natural death is the consequence of cellular differentiation.

Those interested in education will find in this last chapter a fine statement of rapid mental growth of the infant.

Clearly in ultimate analysis the growth of an organism is but a small factor in the problem of its entire life. At a guess, the energy expended in growth is to the entire energy output of the organism as one to one thousand. It should also be remembered in this connection that all the material which enables the embryo to grow so fast at first is a function of the adult life work of the parents. An adult hen may lay 200 eggs in a single year, the materials of which may enable 200 chicks to complete 98 per cent. of their growth at hatching.

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The Development of the Chick: An Introduction to Embryology. By FRANK R. LILLIE. Pp. xi + 472. 251 Figs. New York, Henry Holt and Company. 1908.

The intention of the author of this book is to present in a simple, straightforward way the essential facts of the development of the chick for the use of beginners in embryology. This purpose has been to a very large degree realized, despite the ever-present temptation to enter into comparative discussions.

The book is divided into two sections, the first of which is devoted to a description of the formation of the embryo and is to an exceptional degree original and excellent. The second part, consisting of eight chapters on the development of the organ systems from the beginning of the fourth day of incubation to hatching, occupies a little more than half of the work.

The introduction is a statement of certain embryological theories and facts of general interest which can not properly be included in the body of the book.

The first chapter is a description of the structure, chemical composition and formation of the egg.

So little is known of the processes which occur while the hen's egg is in the oviduct that a consistent account of them is impossible. Consequently, Dr. Lillie in the second chapter bases the description of the development before laying, which includes the fertilization, maturation and cleavage of the ovum, and the formation of the ectoderm and entoderm, upon the work of Harper, Patterson and Blount upon the egg of the pigeon. This is an unavoidable exception to the author's rule of limiting the description to the development of the chick.

The third chapter contains a variety of material such as an outline of development, a statement of the orientation of the embryo in the egg, a discussion of the methods of classifying embryos, and an excellent table of the time of appearance and rate of differentiation of the organs. It would be wiser, perhaps, to omit this chapter because it makes too great a break in the account of the development of the embryo and contains much that the student can not yet understand. The content of the chapter could well be used elsewhere: for example, the section on orientation should be used, I believe, in connection with the account of the formation of the entoderm, given in the preceding chapter. The table, being merely for reference, should be used as an appendix.

The fourth chapter, entitled, From Laying to the Formation of the First Somite, is divided into four sections. The first is a description of the blastoderm in the unincubated egg and amounts to a review of the latter part of the second chapter. The primitive streak is described in the second section under four heads: Whole Views, Sections, The Head Process and Interpretation of the Primitive Streak. This division, especially the separation of the description of the whole views from that of the sections of the primitive streak, seems unwise. Four views of the blastoderm and three sections of the primitive streak of the sparrow, copied from Schauinsland, serve only to show by contrast the excel-

lence and fidelity of Dr. Lillie's figures. The last two sections of the chapter, describing the mesoblast of the opaque area and the germ wall, are very satisfactory. The chapter as a whole is a good account of the origin of the mesoderm.

The fifth chapter, Head-fold to Twelve Somites, is divided into parts upon the head-fold, fore-gut, neural tube, mesoblast and an embryo with ten somites. The attempt to describe the growing embryo, as a whole, breaks down in this chapter, and it might have been better to begin the part upon organogeny at the end of this chapter or earlier instead of after the next chapter. As it stands, portions of this chapter and of the next anticipate statements which are made later.

The second part of the book contains, in addition to chapters on each organ-system, a chapter on the external form of the embryonic membranes and one on the body cavities, mesenteries and septum transversum. There is an extensive and useful bibliography.

The book contains the inevitable errors of a first edition. There is no mention of the origin of the feathers, of the lymphatic vessels and of the muscles of the eye. The anterior division of the embryonic heart is called the bulbus arteriosus, or the bulbus, in the text, index and the original figures, but is named the bulbus cordis in copied figures. The choroid fissure is said to provide "an aperture in the wall of the optic cup for the entrance of the arteria centralis retinæ" (p. 166), but the author himself says elsewhere "There is no arteria centralis retinæ in the bird's eye" (p. 281). Happily such slips are infrequent.

The book contains a large amount of new material, for in addition to the second and fourth chapters upon the development of the egg before laying and upon the origin of the mesoderm, which embody difficult and fundamental research, it makes many small contributions to our knowledge of the embryology of the chick. The value of the book is greatly enhanced by this original matter, which, although it usually serves only to decide between conflicting opinions or to add small details, and although in conformity with the purpose of the book discussion of the literature and of interpretation is reduced to a minimum, gives a great store of facts that will be constantly referred to by students of embryology.

The numerous figures are well chosen and executed, but the publishers have poorly reproduced a number of them. More than half of the figures are new and among these are some very excellent drawings of whole embryos, and new diagrams of the structure of the egg and of the embryonic membranes. Some of the figures of sections could well be replaced by drawings of models.

The typography of the book is unusually good.

Professor Lillie's book, being a comprehensive and accurate statement of the processes by which the body and organs of a single animal are formed, will be of great service in the class-room where the careful observation and correlation of phenomena giving a training in true scientific method, are of more value than a broad and vague knowledge of many things and theories.

Leonard W. Williams

A Canyon Voyage. By Frederick S. Dellenbaugh. New York, Putnams. 1908. 50 plates.

Major Powell's "Exploration of the Colorado River of the West" is famous as a daring enterprise of forty years ago. His first river voyage in 1869 was briefly chronicled in his official report of 1875, and described in a more general manner in a popular book of later issue. His second voyage through the canyon in 1871 from the same starting point at Green River, has never been adequately described, although the results of observations then made were incorporated in the report above cited. At this late date, Dellenbaugh, a member of the second party, who has already written the "Romance of the Colorado River," in which earlier explorations are described, now gives us what he regards as a sequel to his previous book, in the form of a minute narrative of the second boat trip down the river, when he was artist and assistant topographer of the party. There is no attempt at scientific discussion, but a faithful effort is made to record every

item of the journey. In these later years, when amateur travel in the west is frequent, a detailed record of this kind will be of value to seekers after adventure; even if certain parts of the river are unduly dangerous, there are other long stretches in which a boat trip might well be undertaken in a summer vacation without too great disregard of a safe return home. Whether made by scientist, hunter or artist, the journey would surely be repaying in high degree, as one may be assured from the plates, as well as from Dellenbaugh's vivid descriptions. The solitude must be impressive as one floats down the smooth reaches beneath a mighty architecture of bare cliffs. The excitement of running rapids would seem to be sufficient for the most ardent seeker of new impressions. Many of the plates are excellent, although reproduced from photographs taken nearly forty years ago.

W. M. D.

SPECIAL ARTICLES

THE POSSIBLE ANCESTORS OF THE HORSES LIVING UNDER DOMESTICATION[1]

During the later part of the nineteenth century, it was generally taken for granted (1) that "the seven or eight species of Equidæ now existing are all descended from an ancestor of a dun colour more or less striped";[2] (2) that the common ancestor of the living horses, asses and zebras was connected by a single line of descent with the four-toed "fossil" horses of the Eocene period; (3) that the domestic horses are descended from Pleistocene species characterized by large molars with a long anterior internal pillar, a large heavy head and coarse limbs; (4) that in various parts of Europe and Asia, domestic races increased in size and were improved in make, speed and disposition, as a result of artificial selection and favorable surroundings.

On the continent it seems to be still generally assumed that the domestic breeds have descended from a single species,[3] but in England and America many naturalists now believe: (1) That domestic horses have sprung from several wild species connected by several lines of descent with the three-hoofed "fossil horses" of the Miocene period, and (2) that while some of the wild ancestors were adapted for living in the vicinity of forests and upland valleys, others were adapted for a steppe, plateau or desert life.

Of possible ancestors of the domestic breeds, the following may be mentioned: *Equus sivalensis, E. stenonis, E. gracilis* (Owen's *Asinus fossilis*), *E. namadicus*,[4] *E. fossilis* and *E. robustus*.

These species mainly differ in the teeth, size and deflection of the face and in the bones of the limbs. In the first three species the grinding surface of the anterior internal pillar (a fold of enamel on the inner surface of the cheek teeth) of the premolars and first molar, is short—in the last premolar, pm. 4, it may only be one third the length of the crown—in the second three species the anterior internal pillar of pm. 4 and m. 1, is long—at least half the antero-posterior length of the crown. One of the ancestral types (*E. robustus*) was broad-browed and had a short face almost in a line with the cranium; another (*E. sivalensis*), also broad-browed, had a long tapering, strongly deflected face; a third (*E. fossilis*) had a long narrow face, not so strongly bent downwards as in *E. sivalensis*, and a fourth (*E. gracilis*) had a fine narrow, but only slightly deflected, face.

In *E. gracilis* the middle metacarpal (cannon bone) was so slender that the length was seven and a half times the width, while in *E. robustus* the length of the metacarpal was sometimes only five and a half times the width.

Of these possible ancestors, the first three occur in Pliocene deposits, the second three have only hitherto been found in Pleistocene deposits.

[1] Abstract of a paper presented to the Royal Society, London.

[2] Darwin, "Animals and Plants," Vol. II., p. 17.

[3] The latest suggestion is that domestic horses are the descendants of *Equus fossilis* Rütimeyer, a Pleistocene species closely allied to the wild horse of Mongolia—*E. przewalskii*.

[4] *E. namadicus* seems to be closely allied to *E. complicatus*, a species widely distributed in North America during the Pleistocene period.

Equus sivalensis of the Siwalik deposits of northern India is the oldest true horse known to science (*i. e.*, the oldest one-hoofed horse with long (hypsodont) molars), and as it measured about fifteen hands, it is the largest of the old world "fossil" horses. This ancient Siwalik horse was characterized by long, fairly slender limbs and a long tapering face deflected to form an angle of nearly 20° with the base of the cranium. In addition to having a large head, a convex profile and long limbs, *E. sivalensis* seems to have been characterized by a long neck, high withers and a tail set on so high that the root was well in front of the point of the buttock.

Nothing is known of the ancestors of the horse which suddenly made its appearance in Pliocene times amongst the foothills of the Himalayas, but it may be safely assumed that it very decidedly differed from *Pliohippus*, the small "fossil" horse of the late Miocene and early Pliocene deposits of America from which some believe all the recent Equidæ are descended.

It used to be said that *E. sivalensis* could not be regarded as an ancestor of domestic horses because of the shortness of the anterior pillar of the cheek teeth. I find, however, that in some modern horses, the anterior pillars are decidedly shorter than in *E. sivalensis*, and that in some of the short-pillared domestic horses the face is nearly as strongly deflected on the cranium as in *E. sivalensis*. There is hence no longer any reason for assuming that this ancient Indian species had no share in the making of domestic breeds. But in the absence of a large and representative collection of skulls of domestic horses, it is impossible to say which modern breeds are most indebted to the large-headed, long-limbed race, which in Pliocene times frequented the area to the east of the Jhelum River, now occupied by the Siwalik Hills.

Mr. Lydekker thinks *E. sivalensis* or some closely allied race "may have been the ancestral stock from which Barbs, Arabs and Thoroughbreds are derived." When more skulls are available for study and when the phases through which equine skulls pass during development and growth have been worked out, it will probably be ascertained that broad-browed horses with a prominent interorbital region—a forehead convex from side to side as well as from above downwards—and a long tapering strongly deflected face have in great part descended from a species closely allied to *E. sivalensis*, but that slender-limbed horses with a broad flat forehead, and the face short and nearly in a line with the cranium, are at the most only remotely related to *E. sivalensis*.

Further enquiries will probably also show that some Indian breeds, as well as some of the unimproved races of Central Asia (*e. g.*, certain long-faced Kirghiz horses with a sloping forehead and long ears) in many of the points agree with *E. sivalensis* of the Pliocene deposits of northern India.

The second possible ancestor mentioned is *Equus stenonis* of the Pliocene deposits of Europe and North Africa. In a typical specimen of this species with the teeth in an intermediate state of wear, all the anterior pillars of the premolars and molars are shorter than in *E. sivalensis*, while in a specimen with the teeth well worn, the longest pillar may be only one third the length of the grinding surface of the crown—at no age are the pillars of the molars more than half the length of the crown. Whether the face was long and tapering and strongly deflected in *E. stenonis* has not yet been determined, but from the limb bones collected, it is evident that the horse with short-pillared molars, which in Pliocene times frequented the valley of the Arno, sometimes reached a height of nearly fifteen hands.

It is generally supposed *E. stenonis* either became extinct towards the close of the Pliocene age or was modified to form varieties with long-pillared molars. It is conceivable that some of the descendants of *E. stenonis* acquired long-pillared molars, but it by no means follows that all the Pleistocene horses of Europe with the anterior pillars more than half the length of the crown are related to or derived from *E. stenonis*—some of them may have been the descendants of *E. namadicus*.

Be this as it may, horses with teeth of the *E. stenonis* type existed in the south of Scotland during the first and second centuries, and horses with short-pillared cheek teeth are still in existence. In some of the skulls from the Roman fort at Newstead, the anterior pillar of the third and fourth premolars only measures 9 mm.—is only about half the length of the pillar in *E. namadicus* and other "fossil" Pleistocene species. Further, in one of the first century Newstead skulls, the first premolar is as large as in *E. stenonis*, and the face (as broad and long as in *E. sivalensis*) forms an angle of 18° 6′ with the cranium.

Further enquiries may show that the short-pillared species (with metacarpals as long but somewhat thicker than in *E. sivalensis*) widely distributed over Europe and north Africa, in Pliocene times played an important part in the making of Shires and other heavy modern breeds.

The only other possible ancestor dealt with in this contribution is the one to which I have given the name *Equus gracilis*.

Owen arrived at the conclusion that Pleistocene horses "had a larger head than the domesticated races" and that even in small varieties the teeth were nearly as large as in a modern cart horse.

Having come to these conclusions it is not surprising that when it fell to his lot to describe small equine molars from the drift overlying the London Clay and from a cavernous fissure at Oroston, near Plymouth, he decided that they could not belong to a true horse and (on the assumption that they belonged to an extinct ass or zebra) formed for them the species *Asinus fossilis*. In addition to the small second and third molars described and figured by Owen, there is in the British Museum a small first molar from Oreston. The anterior pillars of the second and third Oreston molars are more than half the length of the crown, as in horses of "forest" type, but the pillar of the first molar, m. 1, from Oreston is only about one third the length of the crown, as in *Pliohippus* and *E. stenonis*. Except in size, the small teeth from Oreston and other Pleistocene deposits bear little resemblance to the molars of asses or zebras, but they are practically identical in enamel foldings, as well as in size, with the molars of a small (12.2 hands) slender-limbed horse in the possession of the Auxiliaries who garrisoned the Roman fort at Newstead in the south of Scotland about the end of the first century.

In addition to small equine teeth the Devonshire Pleistocene deposits have yielded a small slender metacarpal. This metacarpal (from Kent's Cave near Torquay) is 220 mm. long and 30.25 mm. wide—the length is hence 7.27 times the width, as in fine-boned Arabs.

As might have been anticipated from a study of the teeth, the Kent's Cave metacarpal belongs to a very much finer-limbed race, than the small horse of the "elephant" bed at Brighton. On the other hand, the Kent's Cave metacarpal very closely agrees with the metacarpals of the small Newstead horse. This small first century horse in teeth and limbs agrees with Exmoor, Hebridean and other ponies of the "Celtic" type, *i. e.*, with ponies characterized by a small fine head, large eyes, slender limbs, five lumbar vertebræ and by the absence of the hind chestnuts and all four ergots.

It hence follows that the small equine of the English Pleistocene (Owen's *Asinus fossilis*) instead of being an ass or a zebra, is a true horse which in the metacarpals as in the "pillars" of the premolars and first molar, differs but little from *Pliohippus* of the late Miocene and early Pliocene American deposits.

Remains of a small horse with teeth and limbs like *Equus gracilis* (*Asinus fossilis* Owen) have been found in the Pliocene deposits of Italy and France, and in the Pleistocene deposits of France and north Africa. The Italian and Auvergne slender-limbed horse has generally been regarded as a small variety of *E. stenonis*. By Pomel and other paleontologists this French variety was known as *E. ligeris*, while the north African variety, named *Equus asinus atlanticus* by Thomas, was regarded by M. Boule as closely allied to, if not the ancestor of zebras of the Burchell type.

The slender metacarpals from the valley of the Arno and Auvergne so closely resemble the Kent's Cave metacarpal and the teeth from Perrier and Puy de Dôme in France and Lake Karar in Algiers so closely resemble the small teeth from Oreston, that *E. ligeris* and *E. asinus atlanticus* may be regarded as varieties or races of *E. gracilis*.

There are good reasons for believing that *E. gracilis* varied to form a northern and a southern variety. Remains of a slender-limbed northern race have been found in deposits belonging to the Neolithic, Bronze and still later ages in Britain and on the continent. At the present day the purest representative of this northern variety is the "Celtic" pony. Hence this northern variety may be known as *Equus gracilis celticus*.

Remains of a slender-limbed southern variety have not yet been found in recent deposits in north Africa, but fine-limbed ponies without ergots and hind chestnuts are sometimes met with in the south of France, and slender-limbed horses without hind chestnuts —horses almost certainly of north African descent—are occasionally met with in the West Indies and Mexico. In the French and still more in the wartless ponies of Mexico the limbs are longer than in the Celtic ponies, the coat is finer, the mane less full and the "tail-lock," so well developed in the northern variety, is very small. As the southern variety in all essential points agrees with Professor Ridgeway's fine bay horse of north Africa (*E. caballus libycus*) it may be known as *E. gracilis libycus*.

Slender limbs and the absence of ergots and hind chestnuts, are apparently as distinctive of members of *E. gracilis* as an upright mane and the absence of hind chestnuts are distinctive of asses and zebras. Hence when as a result of crossing slender-limbed individuals without ergots and hind chestnuts appear in any area it may be assumed that the horses of that area include *E. gracilis* amongst their ancestors.

From enquiries made and from crossing experiments, it has been ascertained that ponies of the "Celtic" type occur in the Färöe Islands and Iceland, in the western islands and highlands of Scotland, in the west of Ireland, in Wales, Exmoor and the New Forest and in Norway and Finland.

Further crossing experiments have made it evident that the yellow-dun fjord horses of Norway are mainly a blend of the "Celtic" and "forest" types, that the Shetland ponies, though usually having the conformation of the "forest" or *E. robustus* type, are in part of Celtic origin, and that some of the mouse-dun Tarpans of the Russian steppes are a nearly equal blend of the Celtic and *E. przewalkii* or "steppe" types.

Professor Ridgeway arrived at the conclusion that in the fine bay horse of North Africa there is a frequent tendency to stripes on the back, legs, shoulders and face, to a blaze on the forehead and to white "bracelets." Experiments made with four types of Arabs and with Russian, Mongolian, Indian and Borneo ponies, English, Irish, Iceland and Norse ponies, support the view that the Pleistocene ancestors of the modern slender-limbed ponies with short-pillared molars was of a yellow or bay-dun color with a narrow dorsal band and bars on the legs, but had neither "bracelets" nor a blaze.

As stripes are most numerous on broad-browed horses with coarse limbs, they have probably in most cases been inherited from ancestors of the "forest" or *E. robustus* type.

As to the part played by *E. gracilis libycus* in forming domestic breeds, nothing very definite has been made out. Professor Ridgeway says all the improved breeds of the world are a blend in varying degrees of the bay horse of North Africa with thick-set, slow, dun and white horses of Europe and Asia allied to *E. przewalskii*. A number of hybrids bred at Woburn by the Duke of Bedford afford little, if any, evidence in support of the view that Barbs, Arabs or thoroughbreds include amongs their ancestors horses of the Prejvalsky or "steppe" type. Slender-limbed horses with a wide flat forehead and a nearly straight profile appear to be a blend of *E. gracilis libycus* (Ridgeway's *E. caballus libycus*) and horses of the *E. robustus* ("forest")

type, while slender-limbed strains with a fine narrow face, a well set-on tail and a mane that clings to the neck, probably most accurately reproduce the variety of *E. gracilis* which in prehistoric times inhabited north Africa.

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THE SOCIETY OF AMERICAN BACTERIOLOGISTS[1]

The Etiology of Plant Tumors: ERWIN F. SMITH. (Illustrated by numerous stereopticon photographs.)

The author prefaced his remarks with the statement that Dr. C. O. Townsend and Miss Nellie Brown were associated with him in the prosecution of this research. The address consisted of a series of lantern slides with running comment. The slides showed inoculated plants of various species and of widely different families, the growths in all cases being the result of pure culture inoculations of the schizomycete *Bacterium tumefaciens*. The crown gall of cultivated plants is cross inoculable to an astonishing degree. In susceptible tissues the signs of these galls appear within as short a time as four or five days. The tumor continues to grow for several months and in some cases for several years and may become 5 cm. or more in diameter. Hundreds of pure culture inoculations have been made. The organism cultivated from the Paris daisy has been inoculated many times successfully into the same and also into the peach, rose, hop, sugar-beet, white poplar and other susceptible plants. That from the crown gall of the peach has been many times successfully inoculated into the peach, and also into the Paris daisy, sugar-beet, hop and other plants. The schizomycete from the hop has been inoculated successfully into the hop and into the Paris daisy, sugar-beet and other plants. One of the astonishing things about this crown-gall organism is the number of families which are subject to infection; in other words, the very simple and generalized nutritional needs of the parasite. In some ways it resembles the root-tubercle organism of Leguminosæ, but is not identical. It has been inoculated into clovers with the production of knots. Quite recently from the hard gall of the apple (selected by Dr. Hedgcock) we have isolated an organism which appears to be like that occurring in other crown galls, and with this, hard galls have been produced upon the Paris daisy. A similar if not identical organism has also been isolated from the hairy root of the apple and successfully inoculated into the sugar-beet, *i. e.*, with the production of similar root-tufts at the point of inoculation. There is now little doubt, therefore, that the hairy root of the apple is also of bacterial origin.

Metastatic growths occur on these plants, but up to this time we have not definitely determined the channels of infection from the primary tumor to the secondary ones. These are easily discovered in the case of the olive-tubercle, but are not readily found in case of these crown galls. The same remark is true respecting the bacteria in the primary tumors. They are very abundant and easily discovered in the olive-tubercle, but not readily detected in the crown gall, although obtainable therefrom in Petri dish cultures on agar. It is still too early in the course of our studies to make positive statements respecting the likeness or unlikeness of these growths to malignant animal tumors, but it is proposed to continue this phase of the inquiry. There is in these growths a very rapid multiplication of parenchymatic tissues with reduction and distortion of the firm conductive tissues of the plant and the final decay and sloughing off of the spongy tissues, leaving open wounds, on the margins of which fresh developments of the tumor may appear.

Seed Corn as a Means of Disseminating Bacterium Stewarti: ERWIN F. SMITH.

In the summer of 1908, in a hothouse on the grounds of the Department of Agriculture, the writer succeeded in obtaining from plants grown from a suspicious seed corn eight times as many cases of Stewart's disease as from plants grown from disinfected seed taken from the same sack. The plants were treated in all respects exactly alike, except that a portion of the seed corn was planted without disinfection and other portions were subjected for ten minutes and fifteen minutes to 1:1,000 mercuric chloride water. The mere statement that there were eight times as many cases in the plants grown from untreated seed by no means expresses the whole truth, because in the plants grown from treated seed all the cases, with four exceptions, were very slight ones, every plant being reckoned as diseased which showed a

[1] In session December 29–31, 1908. These abstracts were received after the general report of the society had been printed in the issue of SCIENCE for June 25.

trace of the yellow slime in the bundles of the stem, although most of the plants so included contained very few affected bundles and did not yet show distinct secondary signs. In the plants grown from untreated seed there were many severe cases of the disease, the entire foliage being dried out and the bacterial multiplication in the vessels of the stem being several thousand times as much as in the cases which appeared in the treated plants. The seed corn was considered as suspicious for two reasons: (1) earlier in the season some plantings in Virginia made from this particular sample yielded many diseased plants, and (2) the corn was grown by a man to whose farm the writer traced a similar outbreak of this disease some years ago.

Various yellow bacteria were obtained from the surface of this corn by means of agar poured-plates, but not *Bacterium Stewarti*, although many attempts were made to isolate it. The latter consequently could not have been very abundant, at least in a living condition, and this may in part account for the small number of cases obtained (10 per cent.). The total cases on the untreated plots were 185 out of 2,017 plants; on the treated there were 36 cases out of 2,370 plants, 32 of these cases being only slightly diseased.

The Occurrence of Bacterium pruni in Peach Foliage: Erwin F. Smith.

Some years ago the speaker made inoculations (by spraying) on the foliage of some peach trees standing in his back yard. The schizomycete used was derived from the black spot of the plum. The sprayings were made late in July, at sunset in rather dry weather. The trees were not covered by tents and the spraying was not continued through the night, as it should have been. The next morning the foliage was dry. After some days, a few bacterial leaf spots developed on one of these trees—perhaps fifty altogether, and a microscopic examination demonstrated the presence of pockets of bacteria in some of these spots, but the experiment was considered in the light of a failure because very few spots appeared in proportion to the amount of culture fluid used, and none at all on one of the trees. Subsequent studies on plums led to the belief that the reason for this failure was due to the age of the foliage and to the fact that the moisture did not remain sufficiently long to secure many infections. In the summer of 1907 these experiments were repeated in one of the hothouses of the Department of Agriculture under conditions which could be more readily controlled. Healthy seedlings and grafted plants of two ages were placed close together on a bench in one corner of one of the hothouses, and heavy canvas was hung in front of the two exposed sides of the bench, so as to make an enclosed area which could be kept moist. River water was then syringed upon the plants (the same that the plants had been in the habit of receiving) and afterwards water dilutions of pure cultures of *Bacterium pruni*, obtained from Arkansas plums. The tent cloth was kept on for two days and the sprayings were repeated at intervals, so that with the exception of two short periods during which the foliage became dry by accident, the moisture was retained upon the leaves throughout the time that the tent cloth was employed. The result of this experiment was the appearance, after a number of days, of several thousands of typical leaf spots. A microscopic examination of many of these spots demonstrated a great number of bacteria in the center of the same, and poured-plate cultures were made therefrom. To obtain numerous spots it is necessary to make inoculations early in the growing season, that is, in May, and to keep the foliage moist from twenty-four to forty-eight hours. The spots obtained on the peach leaves differed in no way from those occurring naturally on peach, and there can be no doubt that the leaf spot of peach is identical with that of the black spot of the plum, both being due to *Bacterium pruni*. All of my experiments, however, have been made with the organism taken from the plum.

Two Sources of Error in the Determination of Gas-production by Microorganisms: Erwin F. Smith.

1. Some microorganisms produce gas from inosit (muscle sugar), consequently in bouillon agar shake-cultures, to which various sugars have been added, the resulting gas bubbles can not be attributed to the sugar added until it is known (*a*) that inosit does not occur or (*b*) that the organism is incapable of fermenting inosit.

2. Some gas-forming microorganisms, *e. g.*, a yeast recently isolated by the writer, do not liberate gas unless the cultures are shaken or stirred, *e. g.*, with a platinum needle. Then gas is evolved abundantly. Ignorance of this fact might sometimes lead to error. It is a fact well known in the Caucasus that the kefir ferment takes place most satisfactorily if the leathern sacks are frequently shaken, and it is said to be the habit for each member of the family to give the sack a kick in passing by it.

SCIENCE

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DOCTORATES CONFERRED BY AMERICAN UNIVERSITIES

FOR the twelfth year statistics have been collected concerning the degrees of doctor of philosophy or of science conferred by the universities of the United States and the data are summarized in the accompanying tables. There were this year conferred 378 degrees, exactly the same number as last year, but an increase of more than 100 over the average of the ten preceding years. Details for these ten years will be found in the issue of SCIENCE for August 30, 1907. The number twelve years ago was scarcely over 200 and now has nearly doubled. Columbia this year conferred 59 degrees, which is the largest number so far from a single institution, and places Columbia before Harvard in the total number of degrees conferred in twelve years, 436 as compared with 418. Chicago with 448 stands first. Yale with 394 stands close to Harvard. The Johns Hopkins, which earlier was at the head of the list, has not maintained its position and is now in the group with Pennsylvania and Cornell. These seven institutions are decidedly before all others in their graduate schools, having conferred 2,579 degrees as compared with 892 by the thirty-five other universities. Among the state universities Wisconsin leads with 110 degrees followed by Michigan with 86 and California with 47.

The second table gives similar details for the natural and exact sciences. Exactly half of the degrees were this year in the sciences whereas in the first ten years covered by these statistics the percentage was 45. Chicago here also stands at the head

TABLE I

DOCTORATES CONFERRED

	Average of 10 years 1898–1907	1908	1909	Total for 12 years 1898–1909
Chicago	35.6	54	38	448
Columbia	32.2	55	59	436
Harvard	33.8	42	38	418
Yale	31.8	32	44	394
Johns Hopkins	30.5	28	27	360
Pennsylvania	22.5	32	29	286
Cornell	18.1	22	34	237
Wisconsin	8.6	17	7	110
Clark	8.7	11	9	107
New York	6.7	15	13	95
Michigan	6.9	4	13	86
Boston	4.4	11	13	68
California	3.3	4	10	47
Princeton	2.6	6	4	36
George Washington	2.8	3	4	35
Virginia	2.8	4	1	33
Minnesota	2.4	3	5	32
Brown	2.3	2	5	30
Bryn Mawr	2.1	4	2	27
Catholic	2.0	1	3	24
Nebraska	2.0	2	2	24
Stanford	1.4	2	3	19
Illinois	.5	5	4	14
Iowa	1.1	2	0	13
Georgetown	1.0	0	0	10
Vanderbilt	.6	1	1	8
Washington	.7	1	0	8
Missouri	.4	3	0	7
Colorado	.5	0	1	6
Indiana	.0	3	3	6
Massachusetts Institute	.3	3	0	6
North Carolina	.5	0	1	6
Cincinnati	.3	0	2	5
Northwestern	.4	0	1	5
Pittsburgh	.1	4	0	5
Washington and Lee	.4	1	0	5
Syracuse	.2	0	2	4
Kansas	.3	0	0	3
Lafayette	.3	0	0	3
Dartmouth	.1	1	0	2
Lehigh	.2	0	0	2
Tulane	.1	0	0	1
Total	271.5	378	378	3,471

TABLE II

DOCTORATES CONFERRED IN THE SCIENCES

	Average of 10 years 1898–1907	1908	1909	Total for 12 years 1898–1909	Per Cent.
Chicago	16.4	37	20	221	49
Johns Hopkins	16.8	17	20	205	57
Columbia	13.4	21	23	178	41
Harvard	14.1	13	14	168	40
Yale	12.4	16	27	167	42
Cornell	10.4	15	24	143	60
Pennsylvania	9.0	18	13	121	42
Clark	7.7	11	8	96	89
Wisconsin	2.8	6	1	35	32
Michigan	2.9	1	5	34	40
California	2.4	2	6	32	68
George Washington	1.7	2	2	21	60
Princeton	1.1	3	3	17	47
Brown	1.2	2	2	16	53
Nebraska	1.3	1	2	16	66
Stanford	1.1	2	2	15	78
Virginia	1.1	2	0	14	42
Bryn Mawr	1.0	1	0	11	41
Minnesota	.7	1	2	10	31
New York	.6	1	3	10	11
Washington	.7	1	0	8	100
Catholic	.5	—	2	7	20
Iowa	.7	0	0	7	54
Indiana	.0	3	3	6	100
Massachusetts Institute	.3	3	0	6	100
Illinois	.3	0	2	5	36
Missouri	.3	2	0	5	71
North Carolina	.3	0	1	4	66
Vanderbilt	.3	1	1	4	50
Washington and Lee	.3	1	0	4	80
Kansas	.3	0	0	3	100
Northwestern	.2	0	1	3	60
Boston	.1	0	1	2	3
Cincinnati	.1	0	1	2	40
Colorado	.2	0	0	2	33
Dartmouth	.1	1	0	2	100
Lehigh	.2	0	0	2	100
Georgetown	.1	0	0	1	10
Lafayette	.1	0	0	1	33
Syracuse	.1	0	0	1	25
Total	123.2	184	189	1,605	46

of the list, having overtaken the Johns Hopkins two years ago. At the Johns Hopkins 57 per cent. of all degrees have been in the sciences, at Cornell, 60 per cent.; whereas at Harvard the percentage is 40, at Columbia 41 and at Yale and Pennsylvania 42. This year just one third of the degrees at Harvard were in the sciences, whereas at Yale the percentage was 60. It is noticeable that sciences do not predominate in the state institutions, as would probably be expected. The percentages of degrees in the sciences for Wisconsin, Washington, California, Nebraska and Minnesota, respectively, are 32, 40, 68, 66 and 31. The change in the position of the leading universities in the number of degrees awarded in the sciences is indicated by the number of scientific men included among the leading 1,000 scientific men of

the United States,[1] who mostly received the doctor's degree prior to or at the beginning of the period covered by these statistics. The numbers are: Johns Hopkins, 102; Harvard, 57; Columbia, 38; Yale, 28; Cornell, 26; Chicago, 23; Pennsylvania, 12.

TABLE III

	Average of 10 years 1898–1907	1908	1909	Total for 12 years 1898–1909
Chemistry	32.0	54	39	413
Physics	15.5	22	25	202
Zoology	14.7	25	18	190
Psychology	13.4	23	21	178
Mathematics	12.1	23	13	157
Botany	12.6	11	16	153
Geology	7.1	5	11	87
Physiology	4.1	7	13	61
Astronomy	3.4	1	7	42
Bacteriology	1.4	1	5	20
Agriculture	1.0	2	7	19
Anthropology	1.0	4	4	18
Paleontology	1.6	1	1	18
Anatomy	.9	2	0	11
Pathology	.5	2	3	10
Mineralogy	.6	0	3	9
Engineering	.8	0	0	8
Metallurgy	.3	0	1	4
Geography	.1	1	2	4
Meteorology	.1	0	0	1
Total	123.2	184	189	1,605

	1908	1909	Total for two years
Economics	17	41	58
English	30	27	57
History	32	22	54
Philosophy	25	14	39
German	14	14	28
Romance Languages	12	14	26
Greek	13	11	24
Latin	12	12	24
Oriental	9	14	23
Education	6	9	15
Political Science	9	4	13
Sociology	6	5	11
Theology	7	2	9
Law	1	0	1
Music	1	0	1
Total	194	189	383

In the third table is given the distribution of the degrees among the different subjects. Chemistry, as always, is at the head of the list, but shows some decrease. Zoology and mathematics are also somewhat below their average, whereas physics and psychology are above; but such changes from year to year are not significant. A real tendency may, however, be indicated by the increased number of degrees in physiology, bacteriology, pathology, agriculture and anthropology.

[1] Cf. Science for December 7, 1906.

The institutions which this year conferred two or more degrees in a science are: in *chemistry*, Yale, 7; Cornell and Johns Hopkins, 6 each; Harvard and Pennsylvania, 5 each; Columbia, 4; in *physics*, Cornell, Johns Hopkins, Pennsylvania and Yale, 3 each; California and Michigan, 2 each; in *zoology*, Columbia, 5; Harvard, 4; Chicago, 3; Johns Hopkins, 2; in *psychology*, Clark, 4; Columbia and Cornell, 3 each; Chicago and Harvard, 2 each; in *mathematics*, Johns Hopkins and Yale, 3 each; Chicago, Columbia and Harvard, 2 each; in *botany*, Chicago, 4; Cornell, 3; Michigan, 2; in *geology*, Chicago and Yale, 3 each; Cornell, Johns Hopkins and Michigan, 2 each; in *physiology*, Yale, 6; Columbia and Johns Hopkins, 2 each; in *astronomy*, California, Chicago and Indiana, 2 each; in *anthropology*, Clark, 3; in *agriculture*, Cornell, 5; in *mineralogy*, Columbia, 2. In other subjects, Columbia leads with 13 degrees in the political sciences. Harvard gave 8 and Columbia 6 degrees in English. The only other instance in which more than four degrees were given by a department was of five degrees in German at Chicago.

The names of those on whom the degree was conferred in the natural and exact sciences, with the subjects of their theses, are as follows:

Yale University

Isaiah Bowman: "The Geography of the Central Andes."

Horace Thomas Burgess: "Point-circle Correlations."

Charlton Dows Cooksey: "Corpuscular Secondary Röntgen Rays."

Arthur Wayland Dox: "The Intracellular Enzymes of Penicillium and Aspergillus, with especial Reference to those of Penicillium Camemberti."

Graham Edgar: "The Quantitative Estimation of Vanadium."

William Ruthven Flint: "The Complexity of Tellurium."

George Edward Gage: "Studies on the Biology and Chemistry of Nitroso Bacteria."

George Frederick Gundelfinger: "On the Geometry of Line Elements in the Plane with Reference to Osculating Vertical Parabolas and Circles."

Fred Harvey Heath: "The Iodometric Determination of Associated Copper, Arsenic and Antimony."

Warren Witherell Hilditch: "Studies on the Influence of Alcohol upon Metabolism."

Albert Wallace Hull: "Ionization produced by Ultra-violet Light of very short Wave-lengths."

Ellsworth Huntington: "Changes in Climate of recent Geological Time."

Israel Simon Kleiner: "Studies in Intermediary Metabolism—the Physiological Action of some Pyrimidines."

Leonard Merritt Liddle: "Studies in Pyrimidines and Research on Halogen Amino Acids."

John Franklin Lyman: "Experimental Studies on the Metabolism of the Purins in the Mammalian Organism."

David Ford McFarland: "Investigation of the Action of Alkyl Halides on some Mercapto Pyrimidines; and a Study of some Molecular Rearrangements in the Amidine and the Thiocyanacetanilide Series."

Victor Caryl Myers: "The Chemistry and Physiology of the Pyrimidines, Thymine, Cytosine and Uracil."

George Elwood Nichols: "A Morphological Study of *Juniperus communis* var. *depressa*."

Levi Fatzinger Noble: "The Geology of the Shinumo Area, Grand Canyon, Arizona."

Joseph Ezekiel Pogue, Jr.: "The Cid Mining District of Davidson County, North Carolina. A Region of Ancient Volcanic Rocks."

Thomas Edmund Savage: "The Stratigraphy of the Lower Paleozoic Formations in Southwestern Illinois."

Mary Davies Swartz: "Nutrition Investigations on the Carbohydrates of Lichens, Algæ and related Substances."

Thomas Smith Taylor: "The Retardation of Alpha Rays by Metal Foils and Gases; and its Variation with the Range of the Alpha Particles."

Edwin Ward Tillotson, Jr.: "On the Synthesis of Malonic Ester, with special Reference to the Influence of Catalytic Agents in the several Reactions."

Mary Shore Walker: "A Generalized Definition of an Improper Multiple Integral."

Hiram Lee Ward: "A Study of Metallic Oxalates, with special Reference to the Separation of Copper as the Oxalate."

Robert Day Williams: "A Study of Reaction Movements."

CORNELL UNIVERSITY

Frank Carney: "The Pleistocene Geology of the Moravia Quadrangle."

Charles Frederick Clark: "A Statistical Study of Variation in Timothy (*Phleum pratense*)."

Marshall Baxter Cummings: "Orchard Survey of Niagara County, New York."

Henry Platt Cushing: "Geology of the Thousand Island Region, New York."

Ludwig Reinhold Geissler: "The Measurement of Attention."

Arthur Witter Gilbert: "Studies of Heredity in Plants."

Clarence Frederic Hale: "Contributions to the Chemistry of Hydrazine."

Chester Deacon Jarvis: "American Varieties of Beans."

Harry Houser Love: "Studies in Variation."

Gustav Ernst Fredrick Lundell: "Anhydrous Hydronitric Acid."

Ellen S. McCarthy: "The Determination of Benzine in Illuminating Gas."

Louise Sherwood McDowell: "Some Electrical Properties of Selenium."

Joseph Vance McKelvey: "The Groups of Birational Transformations of Algebraic Curves of Genus 5."

James Oscar Morgan: "The Effect of Soil Moisture and Soil Temperature upon the Availability of Plant Food."

Taizo Nakashima: "Contributions to the Study of the Affective Processes."

William Henry Pyle: "An Experimental Study of Expectation."

Burton Justice Ray: "Some Trisazo Compounds of Resorcin."

John Moore Reade: "Studies in Sclerotinia."

Donald Reddick: "The Black Rot Disease of Grapes."

Ralph Cuthbert Snowdon: "The Electrolytic Reduction of Nitrobenzene."

John Houston Squires: "Studies of certain Properties of an Unproductive Soil."

Orin Tugman: "The Effect of Electrical Oscillations on the Conductivity imparted to Gases by an Incandescent Kathode."

Chauncey William Waggoner: "A Study of Some of the Physical Properties of a Series of Iron-carbon Alloys at the Temperature of Liquid Air."

John Anderson Wilkinson: "The Phosphorescence of some Inorganic Salts."

COLUMBIA UNIVERSITY

George Herbert Betts: "The Distribution and Functions of Mental Imagery."

Thomas Clachar Brown: "Studies on the Morphology and Development of certain Rugose Corals."

Chester Arthur Darling: "Sex in Diœcious Plants."

Walter Hollis Eddy: "The Synthesis of some Proteid Salts."

Ross Aiken Gortner: "On some New Quinzoline Derivatives."

Louise Hoyt Gregory: "Observations of the Life History of *Tillina magna*."

George Wilber Hartwell: "Plane Fields of Force Invariant under Projective Transformations."

Harry Levi Hollingworth: "The Inaccuracy of Movement (with special Reference to Constant Errors)."

Royal Preston Jarvis: "Investigations on Jigging."

Otto Kress: "Does Thorium exist as Thorium Silicate in Monazite?"

Alfred Hemmer Kropff: "Diaminoisophalic Acid and certain of its Derivatives."

Maurice Allison Lamme: "On the Specific Gravities of Niobium and Tantalum Pentoxides."

Alfred Peirce Lothrop: "The Effects of Bone Ash in the Diet on the Gastro-intestinal Conditions of Dogs."

Charles Searing Mead: "The Chondrocranium of an Embryo Pig, *Sus scrofa:* A Contribution to the Morphology of the Mammalian Skull."

Fernandus Payne: "Some New Types of Chromasome Distribution and their Relation to Sex."

Jacob Rosenbloom: "A Contribution to the Study of the Nature and Origin of the Bince Jones Protein; with Bibliography."

Edward Sapir: "The Takelma Language of Southwestern Oregon."

Charles Edward Taylor: "A New Rapid Volumetric Method for the Determination of Niobium in the Presence of Tantalum and its Application to the Analysis of Niobium Minerals."

Myron Owen Tripp: "Groups of Order p^3q^2. (February 16.)"

Harold Worthington Webb: "A Systematic Study of Electric Wave Vibrators and Receivers."

Maurice Francis Weinrich: "Rutherford Photographs of Stars surrounding B Cygni."

David Day Whitney: "Studies of Sex Determination and Sex Production in *Hydatina senta*."

Herbert Hollingsworth Woodrow: "A Quantitative Study of Rhythm: A Psycho-physical Investigation of Intensity and Duration in Rhythm."

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Walter Van Dyke Bingham: "Studies in Melody and Movement."

Robert Earle Buchanan: "The Morphology of *Bacillus radicola*."

Liborio Gomez y Pineda: "Studies in Rocky Mountain Spotted Fever."

William Duncan MacMillan: "Periodic Orbits about an Oblate Spheroid."

Wales Harrison Packard: "On Resistance to Lack of Oxygen in Animals."

Wanda May Pfeiffer: "The Morphology of *Leitneria Floridana*."

Alma Gracey Stokey: "The Anatomy of Isoetes."

Katashi Takahashi: "Histogenesis of the Lateral Line System in Necturus."

Sister Helen Angela Dorety: "Anatomy of the Seedling of Ceratozamia."

Arnold Dresden: "The Second Derivatives of the Extremal-integral."

Nielsine Johanna Kildahl: "The Morphology of Phyllocladus."

Edson Sunderland Bastin: "Chemical Composition as a Criterion in Identifying Metamorphosed Sediments."

Herbert Earle Buchanan: "Periodic Oscillations of Three Finite Masses about the Lagrangian Circular Solutions."

Thomas Buck: "Oscillating Satellites near the Lagrangian Equilateral Triangle Points."

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Marion Lydia Shorey: "The Effect of the Destruction of Peripheral Areas on the Differentiation of the Neuroblasts."

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Asa Arthur Schaeffer: "Selection of Food in *Stentor cœruleus*."

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Lucas Petrou Kyriakides: "A Contribution to the Study of the Relation between Color and Constitution in the Triphenyl-methane Series."

INDIANA UNIVERSITY

William Edgar Howard: "Stellar Parallax."

Isaac McKinney Lewis: "The Chromosomes in Pinus and Thuja."

Vesto Melvin Slipher: "The Spectrum of Mars."

NEW YORK UNIVERSITY

Arthur Selwyn-Brown: "The Psychology of Evaluation."

Frederick E. Breithut: "The Partial Vapor Pressures in Binary Mixtures."

David Heidon Ray: "The Science of Mechanics."

PRINCETON UNIVERSITY

Lewis Robinson Cary: "The Life History of *Diplodiscus temporatus*."

Bartholomew John Spence: "The Optical Properties of Colloidal Solutions of Gold, Platinum and Silver."

Charles Bell McMullen: "An Experimental Investigation into the Space Coordination of Different Senses."

BROWN UNIVERSITY

Paul Franklin Clark: "The Relation of the Pseudodiphtheria and the Diphtheria Bacillus."

Frederick George Keyes: "The Condensation of Meta-nitrophenylpropiolic Acid to Naphthalene."

CATHOLIC UNIVERSITY OF AMERICA

Richard Stephen Burke: "Theory of Comparison in Psychology."

Thomas Patrick Irving: "The Ultimate Source of the Spectrum."

GEORGE WASHINGTON UNIVERSITY

Harry Wilson Houghton: "The Effect of Cold Storage on Chicken Meat."

George Whitfield Stiles: "The Possibility of Shellfish Contamination from Sewage-polluted Waters."

UNIVERSITY OF ILLINOIS

Robert Stewart: "Quantitative Relationships of Carbon, Phosphorus and Nitrogen in Soils."

Ernest Shaw Reynolds: "Relations of Parasitic Fungi to their Host Plants."

UNIVERSITY OF MINNESOTA

Alois F. Kovarik: "The Effect of Changes in the Pressure and Temperature of a Gas upon the Velocity of the Negative Ions Produced by Ultraviolet Light."

William McDonald: "Agricultural Education."

UNIVERSITY OF NEBRASKA

Clarence Emerson: "The Relation of the Common Milk Streptococci to the Streptococcus Pyogenes."

Joseph Allen Warren: "Agricultural Geography of Nebraska."

LELAND STANFORD JUNIOR UNIVERSITY

John Pearce Mitchell: "The Normal Constituents of the Potable Waters of the San Francisco Peninsula."

Albert Christian Herre: "A Lichen Flora of the Santa Cruz Peninsula, California."

BOSTON UNIVERSITY

Guilielmus Henricus Watters: "The Opsonic Method of Treating Disease."

UNIVERSITY OF CINCINNATI

Robert E. C. Gowdy: "The Fatigue of Metals Subjected to the Roentgen Radiation."

UNIVERSITY OF NORTH CAROLINA

Stroud Jordan: "Condensation of Chloral with Primary Aromatic Amines."

NORTHWESTERN UNIVERSITY

Harold Stiles: "A Determination of Wave-length of the Arc and Spark Spectra of Mercury."

VANDERBILT UNIVERSITY

Allan Fulson Odell: "A Spectographic Study by Means of a Grating (Replica) Spectroscope, and the Determination of the Wave-lengths of the Arc Spectrum of Tantalum."

UNIVERSITY OF WISCONSIN

Willibald Weniger: "Infra-red Absorption Spectra."

DURER'S "CONTRIBUTION" TO GESNER'S NATURAL HISTORY

The statement that Dürer "contributed" one or more drawings to Gesner's famous "Natural History" was called to my attention many years ago, when the error appeared to be sufficiently obvious, but not having the proper materials then in hand, it was not traced to its source.

Attention was again directed to the subject by a recent history of biology, in which it is stated that "his (Gesner's) friend supplied one of the originals—the drawing of the rhinoceros." Again in a delightful essay on Gesner, written some years ago by a revered teacher and friend, we are told that "the names of very few of the draughtsmen and engravers" of the "History" are known, but Gesner says that Lucas Schrön drew the birds, and that Albrecht Dürer made the cut of the rhinoceros.

This suggests that Dürer was not only the author of the engraving, but that he actually made it for Gesner's work, and this impression is confirmed when we read farther on of "His contemporary and friend, Dürer."

The truth of the matter is easily set forth. Albert Dürer made the original of the rhinoceros picture, but he did not "contribute" it to the "Historia Animalium," nor was he strictly a contemporary, or in any sense a friend of the author.

When Albrecht Dürer (1471–1528) died, a world-famous artist, Conrad Gesner (1516–1565) was a lad of twelve, and the "Historia Animalium" (1551–1558) did not begin to appear until nearly forty years after the engraving of the rhinoceros was made and published. Gesner simply borrowed this plate, and in accordance with his commendable custom, acknowledged it in a descriptive note or legend placed beside the cut. Dürer's name here appears for the first, and so far as I have

ascertained, for the only time, in the History. A hasty or imperfect reading of this legend undoubtedly led to the error. The legend freely translated reads as follows:

This is a picture by Albert Dürer, in which that illustrious painter (whose works on drawing still exist) depicts most admirably the Rhinoceros sent to Emmanuel, king of Portugal, at Lisbon, in the year of grace 1515, from the district of Cambay in India. I have lately seen a painting of a Rhinoceros, that is the Nose-horn, representing an animal of this kind, which was recently sent to the king of Portugal from India, and Augustus Justinianus has with certainty identified this very drawing which we here reproduce as a true likeness.[1]

The meaning towards the close of the last sentence is rather obscure. What is literally said is: "Aug. Justinianus recognizes unquestionably this very likeness which we here give." Apparently Gesner intended to say that he had recently seen a painting (presumably from life) of the rhinoceros in question, or of one like it, and that Augustin Justinianus, who had probably seen the animal alive, vouched for Dürer's sketch as a true likeness. Dürer's fame as an artist was sufficient guaranty for the drawing as a work of art, but Gesner wished to make it clear that it was a good likeness and therefore of scientific value also. This is the best interpretation which we can give. The meaning could hardly be that this drawing of Dürer's was a good likeness of the painting referred to, for Gesner had seen both and would be as good a judge as any.

This was the first Indian rhinoceros (*R. unicornis*) to be seen alive in Europe since the days of the Roman amphitheatres, and it naturally created a great sensation. It was sent to Lisbon in 1513, and not in 1515, as stated by Gesner, and without doubt by one of those Portuguese generals who were then making important conquests in India. Possibly more than one of these animals was imported at about this time, the first of which is said to have demolished its cage while on the journey. Emmanuel is further reported to have sent a rhinoceros in the same year (1513) to Pope Leo X., and to have also matched one in a fight with an elephant, in which the latter was worsted.

"Aug. Justinianus," the now somewhat mysterious authority referred to by Gesner, was without doubt the Augustin of that name (1470–1536), at one time bishop of Nebbio in Corsica, and again professor in the University at Paris, a celebrated Oriental scholar, divine and writer of the period. He may have been a friend of Gesner, and at all events had evidently seen the animal referred to alive.

Several artists may have tried their skill in delineating this novel animal, and one at least in the capacity of friend or admirer sent Dürer a description of the beast and enclosed a sketch of it. From these data, and not from a description alone, as has been often asserted, Dürer composed his now famous drawing, which was engraved on wood and first published in 1515. Dürer's original drawing is preserved in the British Museum, and bears on its lower margin, in the artist's own hand, a note, which in translation reads as follows:[2]

Item in the year 1513, on May 1, they brought our King of Portugal at Lisbon such a beast

[1] For the benefit of any who may wish to consult the original, I give the text of the legend as it stands in the first edition of Gesner: "Pictura haec Alberti Dureri est, qua clarissimus ille pictor (cuius etiam libri de pictura extant) Rhinocerotem Emmanueli Lusitaniae regi anno salutis 1515, è Cambaia Indiae regione Ulysbonam allatum, perpulchre expressit. Rhinocerotis, id est naricornis, nuper pictam vidimus imaginem, referentem ex hoc genere animal, quod per haec tempora Lusitano regi ex India allatum est, Aug. Justinianus hanc ipsam indubiè, quam hic damus, imaginem intelligens." Conradi Gesneri medici Tigurini Historiae Animalium, Lib. 1. de Quadrupedibus viviparis. ("De Rhinocerote," p. 952.) Tiguri apud Christ. Froschoverum. Anno M. D. L I.

[2] In addition to assistance received from various friends in the elucidation of certain questions, I desire to specially acknowledge the courtesy of Mr. J. L. Farnum, of the Library of Congress, for supplying the translation of the Dürer inscription and other interesting notes pertaining to this subject.

alive from India, which they call a Rhinoceros. For the wonder's sake I have had to send you a likeness of it. It has a color like a tortoise and is covered nearly all over with thick scales, and in size is like the elephant but lower, and is the elephant's mortal enemy. It has in front on its nose a strong sharp horn, and when the beast comes at the elephant to fight him it has always first whetted its horn sharp against the stones, and runs at the elephant with its head between his forelegs, and rips him up where he has the skin thinnest and so kills him. The elephant is very badly afraid of the rhinoceros, for it kills the elephant whenever it comes at him, for it is so well armed, and very lively and active. This beast is called "Rhinoceros" in Greek and Latin, but in Indian, "Ganda."

In writing this inscription Dürer simply copied the most pertinent extracts from the letter of his correspondent at Lisbon. The original, like so many of Dürer's letters, was probably destroyed, for nothing of it appears in Thausing's work on the artist's literary remains.[3]

According to Hausmann five different editions of Dürer's cut of the rhinoceros appeared, distinguished by varying German text, besides those in other languages. The Library of Congress possesses an impression of the seventh edition with inscription in Flemish, and a reproduction of the first German edition. The translation of this German edition follows closely that on the original drawing, omitting only the last sentence, in which the names of the animal are given. The Flemish inscription also follows the German of the drawing and of the woodcut, with the exception of the following statement:

> This Rhinoceros mentioned above was sent by the King to Germany, to the Emperor Maximillian, and was drawn from life by the renowned Albrecht Dürer, as here represented.

Both of these statements are erroneous, and are curiously contradicted by Dürer's own note to which they are appended.

The remark that this animal was sent to the Emperor of Germany has been repeated by other writers, but is refuted "by the unanimous testimony of the Portuguese historians, Barros, Correa and Albuquerque the Younger, who stated that Manuel sent the creature, on account of its rarity, to the Pope (Leo X.), but that it perished by shipwreck before reaching Rome." Heller in his life of Dürer also discredits the statement, since no mention of the fact is made either in the German inscription, quoted above, or in the life of Maximillian.

Gesner must have read the printed inscription on Dürer's original engraving, of which he made use, but he either did not have it at hand, or used a trimmed copy when writing the note for his History, for he misdates it, and gives additions from other sources.

It must be admitted that Dürer's interesting engraving is a poor likeness of the subject, being faulty in proportion, in the shape and pose of the head, as well as in the remarkable tattooing or ornamentation of the skin. For this, however, the great artist and lover of animals is not to be blamed. Buffon, who gives an account of all the early pictures of this animal, remarks that no really accurate drawings or descriptions of this species existed prior to the publication of a "Natural History of the Rhinoceros" by Dr. Parsons in 1743. The animals which this careful naturalist studied were sent to London in 1739 and 1741, the former coming from Bengal. Buffon considered Dürer's drawing one of the poorest, and remarks upon the most ancient pictures of "nose-horn" extant as follows:

> Those indeed which we see on the ancient pavements of Praeneste and on the medals of Domitian are extremely imperfect; but at least they are without the imaginary ornaments of that of Albert Dürer.

Dürer was without any doubt an enthusiast on natural history, and it is to be noted that he made a hurried, and as it proved, fatal journey to Zealand to sketch a stranded whale. His engravings were widely disseminated, and while good impressions of the subjects have become exceedingly rare and valuable, that of the rhinoceros does not seem to have been greatly sought after by collectors. The original plate is large, measuring within lines

[3] "Dürers Briefe, Tagebücher und Reime," Moriz Thausing, Wien, 1872.

$11\frac{3}{4} \times 8\frac{1}{4}$ inches; in the upper right corner is fixed the word "rhinocerus," between the date "1515," and the well known bold monogram of the artist; there is a scant foreground, and the detailed inscription was added outside the enclosing lines. The impression which the present writer has before him is printed on thin linen paper bearing the water-mark of the peacock, well known to dealers and collectors, and is trimmed to the lines, according to the pernicious custom of an earlier time.

Gesner properly used this print, which must have been common in his day, duly acknowledged it, and added a brief history of the subject for the interest of the general reader. The reproduction, possibly by Gesner's own hand, is almost photographic in accuracy, excepting the accessories of enclosing lines and foreground, which were studiously omitted from nearly all of his illustrations. It was reduced by about one fourth, and was naturally reversed in printing. Although Gesner might have advantageously drawn still further from the great Neurenburg artist for admirable pictures of horses, dogs, stags and hares, he refrained.

FRANCIS H. HERRICK

THE UNITED STATES BUREAU OF EDUCATION

THE Bureau of Education at Washington, which has occupied for thirty-seven of the forty-two years of its existence the rented building at the corner of Eighth and G streets, northwest, was removed in July to the second floor of the old Post-office Department building between Seventh and Eighth and E and F streets, with storage and mailing rooms in the basement. Its new quarters are more commodious and much more comfortable than the old. This is the first time in the history of the bureau that it has been quartered in a government building.

A measure of reorganization in the staff of the bureau was made during the month of July. Mr. Lewis A. Kalbach, who has been connected with the bureau for twenty-two years and has served during the past three years as clerk to the Commissioner, in addition to his duties as specialist in land-grant college statistics, has been appointed chief clerk of the bureau. He has been succeeded as specialist in land-grant college statistics by Professor James E. McClintock, of the University of Maine, whose principal work will have to do with the relations of the federal government with the land-grant colleges of agriculture and mechanic arts. The former chief clerk, Mr. Lovick Pierce, continues his connection with the bureau as chief of the correspondence division. Dr. Harlan Updegraff, who has served as chief of the Alaska division during the past two years, has been appointed collector and compiler of statistics, succeeding Mr. W. Dawson Johnston, who has been made librarian of Columbia University. Dr. Updegraff's principal duties will have to do with the relations of the bureau with the chief school officers of the several states and cities of the country. It is expected that he will serve as an adviser in matters affecting school administration.

Mr. William T. Lopp, who has served as district superintendent of schools in Alaska, has been appointed superintendent of education of natives of Alaska and will have direct charge, under the supervision of the commissioner of education, of education and the reindeer industry among the Alaskan natives. He will divide his time between Alaska and Washington and will have charge of the Alaska division of the bureau.

Some time will be taken in closing up the special work upon which Dr. Updegraff and Mr. Lopp are now engaged, in the Alaska service, and it is expected that they will not enter their new duties before November or December.

Arrangements have been made by the Bureau of Education and the Bureau of the Census for the collection by special census agents of financial statistics of the school systems of the larger cities. The statistical form used by the Census Office will be furnished shortly by the Bureau of Education to a number of these cities that can not be reached this year by the census agents. This form is the outcome of a conference between the two offices concerned.

It is still in an experimental stage, but its use by the Census Office and the Bureau of Education is expected to develop any defects or weaknesses in it, and lead to the adoption of a form that will meet the conditions existing in the various cities of the country.

Another forward step has been taken as regards the prompt issuance of the Annual Report of the Commissioner of Education. On certain conditions, which can undoubtedly be met, the public printer has agreed to furnish bound copies of Volume 1 of the Annual Report for 1909 on December 1 of this year, and volume 2 on March 1 of the year 1910. In view of this arrangement, it may now be confidently expected that the first volume, containing general surveys, directories, etc., will be in the hands of readers before the convening of those educational associations which meet during the holiday season; and the second volume, containing the statistical tables, will be received prior to the Easter vacation meetings.

ELMER ELLSWORTH BROWN,
Commissioner

WASHINGTON, D. C.,
August 9, 1909

SCIENTIFIC NOTES AND NEWS

At a meeting of the Board of Geological Survey of Michigan in Detroit on August 9, Professor R. C. Allen, of the University of Michigan, was elected state geologist to succeed A. C. Lane, whose resignation to accept a chair in Tufts College we announced a month or two ago. Professor Allen had received the endorsement of five out of six of the board of scientific advisers.

At the celebration of the fifth centenary of the University of Leipzig a large number of honorary degrees were conferred, including a doctorate of medicine on Professor E. B. Wilson, of Columbia University, and a doctorate of philosophy on Professor Jacques Loeb, of the University of California.

At its recent celebration the University of Geneva conferred one hundred and fifty honorary doctorates. Among the men of science included were Lord Lister, Professor Haeckel, Professor Ostwald and Professor Engler.

Dr. H. W. Wiley, chief of the Bureau of Chemistry, has had conferred on him the Cross of the Legion of Honor by the French government.

Dr. J. C. Kapteyn, director of the observatory at Groningen, has been elected a corresponding member of the Paris Academy of Sciences.

The Baly medal, awarded by the Royal College of Physicians of London every alternate year for distinguished services to physiology, has been awarded to Dr. Emil Fischer, professor of chemistry in the University of Berlin; and the Moxon medal, awarded every third year for distinguished services to clinical medicine, has been awarded to Sir W. R. Gowers, F.R.S.

The Berlin Academy of Sciences has awarded its Leibnitz medal in gold to M. Ernest Solvay, of Brussels, and to Dr. C. von Böttinger, of Eberfeldt.

The Santaro prize of $2,000 of the Accademia dei Lincei of Rome has been awarded to Professor Quirino Majoranna for his researches in wireless telegraphy.

Dr. Isador Rosenthal, professor of physiology at Erlangen, has celebrated the fiftieth anniversary of his doctorate.

The following professors have retired from active service: Dr. Georg Gerland, professor of geography at Strasburg; Dr. Friedrich Prim, professor of mathematics at Würzburg, and Dr. Anton Grünwald, professor of mathematics at Prague.

Dr. Walter Lehmann, of Berlin, has been appointed curator in the Munich Ethnographical Museum.

Dr. Breinl, of the Liverpool School of Tropical Medicine, has been appointed director of the newly-founded School of Tropical Medicine in Western Australia.

Dr. J. Franklin Meyer, formerly professor of physics at the Pennsylvania State College, State College, Pa., has resigned his professorship to accept a position with the Westinghouse Lamp Company, Bloomfield, N. J., in charge of the physical research.

The Experiment Station Record states that John B. Thompson, for several years connected with the Bureau of Agriculture of the Philippine Islands, has been appointed special agent in charge of the Guam Station, with H. L. V. Costenoble as assistant. Considerable material has been received for the erection of the station buildings. Experimental plantings of forage and other crops from seed secured from the mainland and Hawaii have been begun by the station, and seeds have also been distributed to farmers and others for trial.

William Blum, Ph.D. (Pennsylvania), late assistant professor of chemistry at the University of Utah, becomes assistant chemist in the Bureau of Standards, assuming office on September 1.

President Ira Remsen, of the Johns Hopkins University, is in California engaged in studying the question whether the "sulphuring" process renders fruit unwholesome.

Professor F. B. Crocker, of the electrical engineering department of Columbia University, has leave of absence and starting in October will make a trip around the world.

Dr. M. C. Smith, of Lynn, Mass., sailed on July 23 for Europe to attend the fifth International Dental Congress, of which he is an honorary president, to be held in Berlin the last week in August, and the International Medical Congress at Budapest.

The University of Tubingen has celebrated the centenary of the birth of the celebrated geologist, Friedrich August Quenstedt.

The University of Rochester, Rochester, N. Y., has received under the provisions of the will of the late Rear Admiral William Harkness, professor of mathematics, U.S.N., almost his entire large and valuable collection of astronomical and scientific instruments, and a considerable part of his library. The instruments, including an Alvan Clark telescope, comprised the equipment for a private observatory he intended to erect. The devise of books included over 1,600 volumes, and about 7,000 unbound periodicals and pamphlets. The university has placed the works on astronomy and physics in a separate section of its library, as the basis of a scientific department, to be known as the Harkness Scientific Library.

Dr. Milliken Stalker, for many years head of the department of veterinary science of Iowa College, has died at the age of sixty-seven years.

Dr. O. Fröloch, who took an important part in the development of electrical machinery in Germany and as lecturer at the Charlottenburg Technical School, has died at the age of sixty-six years.

Dr. Johanna Mestorf, until recently director of the Museum for National Antiquities at Kiel, has died at the age of eighty years.

The deaths are also announced of Dr. A. Fraser, professor of anatomy in the Royal College of Surgeons, Dublin, and of Dr. W. Ritz, docent for physics at Göttingen.

The tenth annual meeting of the Astronomical and Astrophysical Society of America opened at the Yerkes Observatory, Williams Bay, Wisconsin, on Wednesday evening, August 18.

The Society for Horticultural Science will hold its annual meeting at St. Catharines, Ontario, Canada, on Monday, September 13, immediately preceding the meetings of the American Pomological Society, which occurs on September 14, 15 and 16. The Welland Hotel will be headquarters for the society. The program will be one of the best which the society has ever had. Dr. L. H. Bailey, of Cornell University, will discuss "The Field of Research Work in Horticulture." Dr. E. W. Allen, of the Office of Experiment Stations, Washington, D. C., will discuss "The Adams Fund in its Relation to Investigations in Horticulture." Dr. H. J. Webber, of Cornell University, will outline the work being carried on there under the Adams Fund Act and Professor S. B. Green, of St. Anthony Park, Minnesota, will outline the work being done under this act at the University of Minnesota. There will be several other papers, but these have not been definitely arranged for at this time.

A Bristol County Academy of Sciences, situated at Taunton, has been organized and incorporated under the laws of Massachusetts. It is proposed to establish a museum with collections selected especially to illustrate the local fauna and flora, to establish a library and reading room, to conduct a laboratory if possible, to maintain a bureau of information, to provide lectures and to issue publications. The president is Mr. Henry F. Bassett, the secretary Mr. A. Cleveland Bent and the curator Mr. Frederic H. Carpenter.

The attendance at the New York Aquarium during July was 528,266, an average of 17,040 per day. The total attendance for 1909 to August 2 has been 2,006,919.

The University of Utah archeological expedition that is making excavations and studies in the San Juan country reports that it has secured a large quantity of material and has been successful in its investigations. Byron Cummings, dean of the school of arts and sciences, is in charge of the expedition. During the coming year he will pursue archeological studies in New York and in Europe.

The junior class in mining engineering of the Case School of Applied Science spent the month of June studying the mines, mills and geology of the Black Hills, near Deadwood, Lead and Terry. The students were accompanied by Dr. A. W. Smith, professor of metallurgy, Dr. Frank R. Van Horn, professor of geology and mineralogy, and Mr. R. R. Abbott, instructor in mining engineering. During July, Professor Van Horn, with a few of the party, spent over two weeks in the Yellowstone National Park, entering by way of the Cody, Wyoming, road over the Sylvan Pass, and returning through Gardiner, Montana.

We learn from the London *Times* that the collection of fossil Brachiopod shells made by the late Mr. John Francis Walker, F.G.S., of York, has lately been presented to the British Museum (Natural History) by his executors. It represents the life-work of Mr. Walker, who formed it with the special intention of illustrating the nature of animal species and the laws governing the change of one species into another. He chose Brachiopods for his purpose on account of their abundance in the rocks of all geological ages, and arranged them in groups to exhibit their variations round certain apparently central forms. The collection consists of several thousand specimens chiefly from the English Jurassic and Cretaceous formations, and will be kept for the most part in the original cabinets in the Department of Geology, near the well-known Davidson collection. Some of the more important specimens, especially those described by Davidson, will shortly be exhibited in the public gallery. The case containing the okapis has been enriched by the addition of the skeleton of the animal whose mounted skin, presented by Major Powell-Cotton, is also shown. The two other specimens are the original female, presented some years ago by Sir Harry Johnston, and a male presented by Captain Boyd Alexander. In the upper gallery a very fine specimen of the Tibetan langur (*Rhinopithecus roxellanæ*) has just been put out. This curious monkey, distinguished at once by its "tip-tilted" nose, was discovered by Père David and described by Milne-Edwards. Near the entrance to this gallery is a young flying lemur (*Galeopithecus volans*) mounted on a tree stem to show its protective coloration. To the fish and reptile gallery the leathery turtle (*Dermochelys coriacea*), taken at Pwllheli last summer, has been added. It was impossible to preserve the animal, so that only the carapace and skeleton are shown.

On July 21 Lord Monk Bretton, as reported in *Nature*, asked in the House of Lords what steps had been taken to define the spheres of the Boards of Agriculture and Education, respectively, in the matter of agricultural education. At the same time he referred to the memorandum recently issued by the Board of Education, which implied that a sum of £21,000, in part at any rate, is available for agricultural education. He stated that he has been in communication with the university authorities and others, and can find no evidence that the money is used for this purpose. Similarly, the Treasury grants and the block-

grant system of the Board of Education have not helped agricultural education; money from the latter source, indeed, goes to the relief of the rates. British agriculture, he pointed out, receives much less money than the amount granted in foreign countries, a result due to the absence of agreement and coordination between the Board of Education and the Board of Agriculture. Earl Carrington, in reply, stated that an understanding had that morning been arrived at by the two boards as to the general lines of their future policy. There will be direct cooperation in regard to educational work, and in particular with the view of improving and extending specialized agricultural instruction. An inter-departmental committee of officers of the two boards will consider the questions that may arise as to the correlation of work and of grants. Everything is working harmoniously between the two departments. Lord Belper strongly urged that any arrangement between the two boards should follow the recommendation of the Agricultural Education Committee that agricultural education provided by colleges, farm institutes and winter schools should be under the direction of the Board of Agriculture, while agricultural instruction given at evening classes connected with elementary schools should be under the Board of Education. The Marquis of Lansdowne emphasized the great importance of the subject. Quoting Sir Horace Plunkett's dictum, that what is wanted in these days is not merely economic holdings, but an economic system and an economic man to carry it out, he went on to say that we can not get the economic man to carry out the economic system unless the government takes some pains to give him a proper education.

From her state forests France derives an annual income of approximately five million dollars, or $1.75 per acre. Eighteen per cent. of the entire area of the country, or 23,500,000 acres is forest land. Approximately six million acres are managed by the state, the annual cost of management being ninety-five cents per acre. The great achievement of France in forestry has been the establishment of protective forests where much destruction has been caused by floods. Toward the close of the eighteenth century about 2,500,000 acres comprised in the Department of the Landes were little more than shifting sand dunes and disease-breeding marshes. This section is now one of the richest, most productive and healthful in France. This change has been brought about by the intelligent cultivation of pine forests. Immense forests now cover the country, the sand dunes and marshes have long since disappeared, and the wood, charcoal, turpentine, rosin and kindred industries have brought prosperity to the department, which was formerly the most barren and miasmatic in France. The climate is now mild and balmy, the great change being wrought by the forests. The thin layer of clay beneath the sandy surface, formerly impervious to water, has been so pierced by the roots of the pine that there is now thorough drainage to the spongy earth below. The manufacture of rosin, tar, turpentine, pitch, pyroligneous acid and wood vinegar is conducted about the same as in Georgia and the Carolinas. The trees destined for "short life" are bled as soon as they are big enough to stand bleeding, when they have a circumference of a foot or fifteen inches, the sapping of young trees being the only production of a new forest for a time, and when the "thinning out" time comes they are "bled to death," and the timber used largely for pit props, the English demand guaranteeing a steady and profitable market. The "standing trees," those giving promise of most vigor, are never tapped until they are about three feet in circumference. When these have reached the age of fifty or sixty years they are cut down, and utilized for telegraph poles and railway ties. To prevent the spread of forest fires, wide trenches are dug about limited areas, and the space kept clear.

The Society of Anthropology, Paris, has celebrated, in the great amphitheater of the College of Medicine, the fiftieth anniversary of its foundation. M. Bayet, director of higher education at the Ministry of Public Instruction, presided, and a great number of

delegates from France and foreign societies were present.

UNIVERSITY AND EDUCATIONAL NEWS

We learn from the *Experiment Station Record* that the legislature of Minnesota has passed an act providing state aid for ten high schools or consolidated rural schools which maintain agricultural and industrial departments. The state will pay two thirds of the expense to maintain these departments provided that each school employs trained instructors in agriculture, manual training, and domestic science, possesses not less than 5 acres of land suitable for school gardens and experimental and demonstration purposes, and that the total expenditure for each school does not exceed $2,500. The ten schools selected are the high schools at Albert Lea, Alexandria, Canby, Glencoe, Hinckley, Red Wing and Wells, the high schools and associated rural schools at Cokato and McIntosh and the consolidated school at Lewiston. The act also provides that not to exceed ten schools may be added to the list during each succeeding biennium.

The assembly of Iceland has decided to establish a university at Reikjavik, with four faculties and sixteen professors and lecturers.

The number of students in the universities of the German empire has this summer reached 51,700, an increase of about 3,000 over last winter and of 4,000 over the summer of 1908. There has been a large increase in the faculties of medicine and philosophy and a decrease in the faculty of law.

G. W. Stewart, A.B. (DePauw, '98), Ph.D. (Cornell, '01), has been elected professor of physics and head of the department at the State University of Iowa, to fill the vacancy caused by the removal of Professor Karl E. Guthe to the University of Michigan.

At the University of Wisconsin, Mr. E. E. Eldridge, of New York, a graduate of Cornell University, has been appointed assistant in bacteriology. Mr. Albert I. Stevenson, Massachusetts Institute of Technology, has been made chemist in the State Hygienic Laboratory connected with the university. In the engineering college faculty Mr. Charles G. Buritt, '09, Mauston, has been appointed instructor in railway engineering, and W. C. Muhlstein, '09, Grand Rapids, assistant in the same department. J. A. Cutler, '09, Dodgeville, is instructor in topographical engineering. George B. Blake, '08, Huron, S. D., and S. S. Hovey, a graduate of Iowa State College, are new assistants in electrical engineering. B. S. Wood, who was formerly instructor in wood work, is now instructor of pattern work.

The following changes in the faculty of the University of Utah are announced: Frank A. McJunkin, M.D. (Michigan), now instructor in bacteriology at the University of Michigan, succeeds Ross. Anderson, M.D., as professor of bacteriology and pathology and becomes state bacteriologist and pathologist; R. B. Ketchum, C.E. (Illinois), at present chief engineer of the Kansas and Colorado Railroad Co., becomes assistant professor of civil engineering; A. A. Knowlton, A.B. (Bates), A.M. (Northwestern), now associate professor of physics at Armour Institute, succeeds L. W. Hartman, Ph.D., as associate professor of physics; Wm. H. Chamberlin, A.B. (Utah), A.M. (California), becomes lecturer in philosophy, and Kenneth Williams, B.S. (Pennsylvania), now chemist for the Tintic Smelter, becomes instructor in chemistry.

Dr. I. M. Lewis, instructor in botany in New Hampshire College, has been appointed instructor in botany in the University of Texas.

The Belfast University commissioners have made the following appointments in the Queen's University, Belfast: *Professorships*—Botany: Mr. D. T. Gwynne-Vaughan, M.A. Cantab., formerly lecturer in botany, Glasgow University and Birkbeck College, London. *Lectureships*—Organic chemistry: Mr. A. W. Stewart, D.Sc. Glasgow, lecturer in stereochemistry and assistant to Professor Sir W. Ramsay, University College, London. Physics: Mr. Robert Jack, M.A., D.Sc., Ph.D. Glasgow and Göttingen. Bio-chemistry: Mr. J. A. Milroy, M.A., M.D. Edinburgh, demonstrator of physiology, Queen's College, Belfast. Geology and geography: Mr. A. R. Dwerry-

house, M.Sc., D.Sc., F.G.S., assistant lecturer in geology, Leeds University. Hygiene: Mr. W. J. Wilson, B.A., M.D., R.U.I., Riddell demonstrator of pathology and bacteriology, Queen's College, Belfast.

DR. ARTHUR ROBINSON, professor of anatomy in the University of Birmingham, has been called to the chair of anatomy in Edinburgh University, rendered vacant by the death of Professor D. J. Cunningham.

Nature is informed that the appointments to the chairs of chemistry in the Technical High School at Munich have just been officially announced. The names of the professors are: Organic chemistry, Professor Semmler; inorganic chemistry, Professor A. Stock; physical chemistry, Professor R. Abegg. Each professor has an institute of his own, and Professor Abegg retains, at the same time, his position as extraordinary professor in the University of Breslau. The Technical High School, which is being built at a cost of something like five million Marks, is making good progress, and is to be opened officially in October, 1910.

DR. F. RINNE, professor of mineralogy at Kiel, has been called to Leipzig.

DISCUSSION AND CORRESPONDENCE

TELEGONY AS INDUCED REVERSION

DARWIN and many other students of heredity have believed in telegony, and have collected many alleged examples. The typical instances were the striped colts produced by mares that had previously borne quagga hybrids.[1] The original theory of telegony assumed that the stripes of the later colts were inherited from the quagga sire of the first colt. Various attempts have been made to show how this could come about, but they were not able to secure scientific credence.

The tendency shown in Thomson's "Heredity" and other recent handbooks is to deny telegony altogether and to treat the alleged cases as ordinary instances of reversion. In Morgan's "Experimental Zoology" telegony is dismissed as "another breeder's myth," and is used as an illustration of the "credulity of men who have not been trained as to the value of evidence."

It is curious that this zeal for evidence allowed the fact to be overlooked that Darwin knew of three striped colts following quagga hybrids, instead of only one. This oversight may be partly responsible for the verdict reached in Professor Morgan's discussion of the supposed single case: "There was, then, merely a coincidence, and not a causal connection."

The additional evidence collected by Ewart has bearing upon the nature of the facts that have been grouped under telegony, but it does not explain the occurrence of such phenomena as sequels of hybridization. To reckon the striped colts as examples of reversion affords no proper warrant for denying any connection with the fact that the mares had previously borne quagga colts, or for assuming that such reversions are without scientific interest or practical importance. To know that characters of remote ancestors are likely to return to expression in progeny that follow hybrids may be quite as significant, from the standpoint of heredity, as the idea of long-range transmission from the male parent of the hybrid.

Before pronouncing telegony a myth, a further possibility should be taken into account, that the stripes of a later colt may be induced by the previous contact with the quagga, not through any form of transmission or "infection" with character-units or primordia from the quagga, but by giving a stronger tendency to expression to a primitive characteristic already included in latent form in the reproductive cells of the female. In his hybrids between zebras and horses Ewart found that the stripes were not like those of the striped parent, but of a much more complex pattern, indicating that a primitive character of some remote ancestor came into expression, instead of a character directly transmitted from the zebra. Ewart does not use his evidence to prove that striped colts following hybrids are mere coincidences, but to show that the theory of long-range transmission from the male parent is unnecessary.[2]

[1] "The Variation of Animals and Plants under Domestication," Chapter XI.

[2] Ewart, J. C., "The Penycuik Experiments," 1899.

Many external and internal conditions which do not appear to affect the *transmission* of characters are able to influence the *expression* of characters. Differences of heat and light, as well as of foods, chemicals and internal secretions (enzymes) are now known to induce changes in the expression of characters. Without the thyroid gland the remainder of the body does not complete its growth. Castrated animals may grow to abnormal size, but fail to develop secondary sexual characters. Parasitic fungi, insects and mites induce the development of galls and other changes in the habits of growth of their host plants. Horticulturists have learned that scions have definite influences upon the characters of the roots on which they are grafted. Plants grown under new and unaccustomed conditions often show wide ranges of individual variation, recalling many ancestral characters to expression. There is no ground for denying the possibility that similar reversions might follow impregnations by diverse types.

The fact that Ewart found only faint stripes on colts that followed his zebra hybrids does not destroy the older evidence that more vivid stripes, as well as peculiarities of mane and hoofs, followed the earlier instances of hybridization with the quagga, an animal of a different species, now reckoned as extinct. Atavistic changes have been found to be more frequent and more pronounced in some series of hybrids than in others, even in the same group of organisms. When our United States Upland cottons are crossed with the Kekchi cotton of Guatemala the hybrids have lint shorter than either parent, but when the Kekchi cotton is crossed with the Egyptian the lint is as long as in the Egyptian parent, or even longer. With hybrids, as with the parent stocks, external conditions often appear to have a definite influence upon the expression of characters. Hybrids of the same parentage may show Egyptian habits of growth under some conditions and Kekchi habits under others.[8]

[8] "Suppressed and Intensified Characters in Cotton Hybrids," Bulletin 147, Bureau of Plant Industry, U. S. Department of Agriculture.

The frequent occurrence of stripes in mules may also mean that hybridization has a tendency to induce this form of reversion. There is no reason to suppose that the stripes come from the asinine ancestry alone. Striped mules seem to be especially common in tropical countries, where unfavorable climatic conditions and the mixing of the breeds of horses may further increase the tendency to reversion. A vividly striped mule of a yellowish, zebra-like ground-color, seen at Cordoba, Mexico, a few years ago, gave me a better appreciation of the extent to which such reversions may sometimes be carried. The conspicuous markings of the legs happened to be seen first, the more uniform body of the animal being concealed by a wagon. I stepped into the street expecting to find a traveling managerie.

The possibility of bringing telegony into relation with other induced forms of reversion adds nothing, of course, to the evidence that reversions are induced by previous hybridization. Facts may establish theories, but theories do not establish facts, except as they lead to further observation. If enough reversions of the same kinds are found to occur without previous hybridization it will be reasonable to view all the alleged cases of telegony as coincidences. If reversions prove to be more frequent after hybridization telegony will be established, though its manifestations may not be otherwise different from reversions that occur without hybridization.

Negative evidence may show that induced reversions are rare, but does not affect the authenticity of particular cases, as Ewart himself perceived. Xenia also has appeared to be very rare in nature at large, but its frequent occurrence in maize is no longer doubted, and an explanation has been found in double fertilization, enabling the endosperm as well as the embryo to share the characters of the male parent. We need not feel obliged to discredit facts like those collected by Darwin and other students of heredity merely because an erroneous theory suggested the name telegony.

Pearson's plan of proving or disproving telegony by a statistical study of the degrees

of resemblance of children to fathers rests more on mathematical ideas than on biological indications, to judge from Thompson's account of it. To show that later children resemble their fathers more than earlier children would not demonstrate a cumulative paternal influence, but might only mean that children of older parents have less tendency to vary from parental characters than children of young parents. It would still be necessary to show that the paternal resemblances of the later children increase more than their maternal resemblances.

O. F. COOK

WASHINGTON,
April 30, 1909

SCIENTIFIC BOOKS

A Comparative Study of the Thorax in Orthoptera, Euplexoptera and Coleoptera. By R. E. SNODGRASS. *Proc. Ent. Soc. Washington,* IX., 1908, pp. 95–108, pls. II.–V.

The Thoracic Tergum of Insects. By R. E. SNODGRASS. *Ent. News,* March, 1909, pp. 97–104, pl. VI.

The Thorax of Insects and the Articulation of the Wings. B. R. E. SNODGRASS, of the Bureau of Entomology, U. S. Department of Agriculture. No. 1687—Proceedings U. S. National Museum, Vol. XXXVI., pp. 511–595, with plates 40–69. Published June 18, 1909.

The series of memoirs, under the above titles, constitutes a very valuable addition to the literature of insect structure. The last paper contains the detailed evidence for the theories presented by the other two and is really considerably broader than the title indicates, including an elaborate discussion of the segmentation of the head and abdomen and is not limited to a study of adult structure.

The diagrams (Figs. 1–6) present in an extremely satisfactory manner the author's views on the structure of the thorax, and the "glossary and synonymy" (on pp. 570–583) will prove more than ordinarily useful to subsequent students of this subject. Many will agree heartily with the protest against the tendency to explain all structural differentiation of a segment by the supposition of a multiple origin. It is pointed out that if segments have been lost they have been suppressed and not fused and are not represented by the present subdivisions of the segments.

There may be less assent to the idea of separating the labial segment from the head, there would be more reason for considering the prothorax as not forming part of the thorax. Much is added to our knowledge of the detail of the sternal and pleural structures, but nothing added to the interpretation of their significance beyond the accumulation of evidence against their supposed double origin and in favor of the single origin urged by myself several years ago[1] and the elevation of the occasionally partially chitinized articular membrane to the position of a component part of the segment under the names of the presternum and preepisternum.

In reference to the notum we find the most radical views. This region is conceived of as consisting of two parts, one the original chitinized portion of the segment, the other a new sclerite resulting from the chitinization of the articular membrane. This last portion is identified as the postscutellum of Audouin, the division between other three regions of the notum are supposed to be of relatively recent origin and not to be homologous through the group, since they do not correspond with a system of internal ridges which are considered as comparable in all insects.

It is probable that in some groups many authors have made mistakes in properly homologizing the various parts of the dorsum, but there has not yet been offered enough evidence to cause us to overturn at once the older nomenclature.

The scutum is the piece bearing the wing processes. Exactly what its anterior border is may be a question for discussion. Posteriorly it is probably bounded by the "V-shaped ridge," but here again we may have an unsettled question. The piece behind the scutum is the scutellum. There is no difficulty in most cases in recognizing it, but its exact boundary may again be an unanswered ques-

[1] "The Wing Veins of Insects," Univ. of Calif. Publications, Entomology, Vol. I.

tion. It is to be regretted that the author did not bring out the homology of these two great regions of the notum and devote his energies to the determination of the real boundaries of these regions.

The interpretation of the origin of the post scutellum or pseudonotum, as he calls it, was suggested by myself in the paper previously referred to, though I can not agree in considering this region belonging more to the segment in front than to the segment behind, particularly when the phragma is considered as part of this interpolated sclerite.

The great dorsal muscle of flight for which the phragma was developed is probably only a dorsal intersegmental muscle. These extend from the anterior edge of one segment to the corresponding part of the next. The anterior phragma is mesoprescutal, the posterior is a part of the first abdominal segment. The hymenoptera appear to be an exception in regard to the position of the first abdominal segment, only because of the great constriction between the first and second segment.

It may be impossible on anatomical grounds to locate the division between segments after the articular membrane has become wholly chitinized. The phragma may be, as this author says, a "chitinization of the infolded intersegmental membrane," but if so, why is not the deepest point of the fold the point of demarkation between the segments?

A more reasonable position would seem to be that the infolding for the attachment of intersegmental muscles marks the posterior boundary of the prescutum that the phragma belongs therefore entirely to the following segment and that with the completion of the chitinization of the articular membrane, the division is lost somewhere immediately anterior to the phragma.

The region designated by this author as pseudonotum developed as a chitinization of the articular membrane is probably therefore made up of two elements, one of which is continuous with the prescutum of the following segment.

The articulation of the wing has been studied in much detail, but scarcely anything is added to the work of Amans except the application of the Comstock-Needham nomenclature to the veins. The veins are said to be "connected or associated in a very definite and constant manner with the sclerites of the wing base," but speaking of the chief vein in the wing he says: "The base of the radius is nearly always more or less closely fused with the base of the subcosta but it is clearly connected also in a great many cases with the anterior end of the second auxiliary. In other examples its head is only contiguous to the third auxiliary." This does not seem to be very definite nor constant.

The study of the articulation throws but little light on the question of the homology of the veins because of the fact that in all orders except Odonata and Ephemerida, the basal connection of the veins has been disturbed to enable the wing to fold back against the body. Indeed the basal connections of the veins are very unreliable and are not depended on by any one in the determination of the homologies of the veins.

The presenting of theories is condemned by the author in numerous places and this article is offered as an accumulation of facts and conclusions, but it is very difficult to see the distinction. Theories in truth constitute the whole of science. Facts are nothing unless they mean something, and our interpretation of that meaning is what we really present. A drawing is at best a crude representation of the object and its only use is to represent our theory of what we see. The present paper contains over two hundred excellent drawings with very full explanations which will enable subsequent students to comprehend exactly what the interpretation of the structures were and I feel sure that in most particulars they will concur with his conclusions.

C. W. Woodworth
University of California

A Short Handbook of Oil Analysis. By Augustus H. Gill, S.B., Ph.D. Fifth Edition. Philadelphia, Lippincott & Co. $1.50.

A book on chemical analysis which has five editions in twelve years is very nearly beyond criticism; fault finding is disapproved in advance, and praise is but gilding the re-

fined gold of royalty. But a man so generally popular as Dr. Gill gets all the praise that is good for him, anyway; so it may be observed that there are some things in which this book may yet be improved. The illustrations are better than none, but not much; and the directions for using flash-test apparatus are not quite as complete as a beginner ought to have. It should always be remembered that a metallurgical or cement chemist, for example, skilled in using ordinary apparatus, may know nothing at all about a flash-test; and it is in little details that the manipulation of the expert excels and has its greatest value. In most cases the directions given in this book are full and clear.

The inclusion of refractive indices would probably be generally approved, since the refractometer has come into general use. In general, the book would be better if there were more of it; and while its value is partly due to leaving out information not useful to the analyst, some further remarks as to the nature of the various oils, as well as to changes produced by reagents, from one so experienced as the author, would be of much use to the student.

Somewhat more than half of the book is given to physical and chemical tests; then there are descriptions, including preparation, uses, tests and constants for the chief petroleum products, for seventeen vegetable and nine animal oils, and certain waste fats and greases. There is an appendix of tables and other information. The book has been largely rewritten and has a good index; it appears to be free from typographical errors.

A. H. Sabin

SCIENTIFIC JOURNALS AND ARTICLES

The American Naturalist for May presents two papers, and notes: "The Categories of Variation," by S. J. Holmes, in which the author discusses the differences between fluctuating variations and mutations; going to some length in the analysis of elementary species, retrograde varieties and fluctuations, as distinguished by De Vries; with the general conclusion that the evidences, so far presented, do not sufficiently distinguish between unstable mutations and fluctuations. "The General Entomological Ecology of the Indian Corn Plant," by S. A. Forbes. "Notes on Some Recent Studies on Growth," by Raymond Pearl; "Cuénot on the Honey-bee," by T. H. Morgan; "Poulton and Plate on Evolution," by V. L. K[ellogg].

The American Naturalist for June presents four papers, and notes: "Heredity and Variation in the Simplest Organisms," by H. S. Jennings. "The Color Sense of the Honey-bee: is Conspicuousness an Advantage to Flowers"? by John H. Lovell; with the adduced evidence that the query is to be answered affirmatively. "Variation in the Number of Seeds per Pod in the Broom, *Cytisus scoparius*," by J. Arthur Harris. His conclusion is that for this species variability due to habitat is not more noticeable where it is introduced than where it is native. "Present Problems in Plant Ecology." These are presented in two articles read before the Botanical Society of America at the Baltimore meeting, 1908: (1) "The Trend of Ecology," by Henry C. Cowles, and (2) "Present Problems of Physiological Plant Ecology," by Burton E. Livingston. Under "Notes and Literature" V. L. K. makes note, under the heading of Evolution, on the retirement of Ernst Haeckel from his chair in the University of Jena, with emphasis upon the establishment and care of his new Phyletic Museum. He also notes the recent German discussion of mechanical versus vital basis for explaining phenomena of nature. George H. Shull notes the literal translation into French of Hugo De Vries's "Species and Varieties: their Origin by Mutation." J. F. McClendon presents a note on "The Totipotence of the First Two Blastomeres of the Frog's Egg."

SPECIAL ARTICLES

ON THE CONNECTION BETWEEN STIMULATION AND CHANGES IN THE PERMEABILITY OF THE PLASMA MEMBRANES OF THE IRRITABLE ELEMENTS

Evidence of a varied and highly conclusive kind now exists that the phenomena of stimu-

lation in irritable or contractile tissues depend primarily on a temporary and readily reversible increase in the permeability of the surface films or plasma membranes of the constituent cells or elements. This evidence is essentially as follows.

1. Those motile organs and tissues in plants where movement is due to changes in the turgor of the cells present perhaps the clearest case (osmotic motile mechanisms: sensitive plants, *Dionæa,* stamens of Cynareæ, etc.). In *Mimosa pudica* (*e. g.*) the movement results directly from a sudden loss of turgor in the pulvinus cells, due to the escape of a fluid containing considerable dissolved matter. This effect indicates very clearly a sudden increase in the permeability of the protoplast in relation to the dissolved substances of the cell-sap. Movement in these plants is excited by the usual stimulating agencies and is accompanied by an electrical change or "negative variation" similar to that observed in the irritable tissues of animal during stimulation (Burdon-Sanderson). These conditions show (1) that in resting cells, at least of turgid plants, the normal state is one of almost absolute impermeability to the dissolved crystalloid substances within the cell combined with free permeability to water—otherwise the maintenance of turgor would be impossible; and (2) that during stimulation this semi-permeability is temporarily lost.

2. In animal cells the evidence of increased permeability during stimulation is less direct. That in this case also a high degree of impermeability characterizes the plasma membranes is shown by the phenomena of plasmolysis, by the inability of many dyes to enter the living cell, and by the failure of many dissolved crystalloid substances (sugars, neutral salts) appreciably to enter the suspended cells in fluids like blood (Hedin's researches). That stimulation is associated with an increase of permeability is indicated by the fact that most stimulating agencies (heat, various chemical substances, mechanical action, electrical shocks) also visibly increase the permeability of pigment-containing cells like blood-corpuscles, as shown by their laking action. Direct evidence of increased permeability during strong stimulation is also seen in certain favorable organisms, *e. g., Arenicola* larvæ (see below).

3. Evidence that semi-permeable membranes are concerned in stimulation is seen in Nernst's proof that the stimulating action (s) of alternating currents decreases with an increase in the number of alternations per second according to an apparently quite definite rule ($s = i/\sqrt{m}$, where i = intensity of current and m number of alternations). This indicates that changes in ionic concentration at the semi-permeable surfaces of the irritable tissue—*i. e.,* at the plasma-membranes—are an essential condition of electrical stimulation. A corollary of this theory is that if during stimulation the permeability is increased so that the semi-permeability of the membranes temporarily vanishes, stimulation should become temporarily impossible; the existence of a refractory period is thus indirect, but strong evidence of a marked increase in ionic permeability at the height of stimulation.

4. The assumption that stimulation is associated with an increase in the permeability of the semi-permeable membranes also explains the characteristic electrical phenomena of irritable tissues. If the irritable element, *e. g.,* muscle-cell, be regarded as a concentration-element in which the potential-difference between exterior and interior is due to a separation of ions at the plasma membrane, which is assumed to be readily permeable during rest to certain cations (probably hydrogen ions) but not to anions (Ostwald-Bernstein "membrane-theory")—the sudden fall of the demarcation-current potential during stimulation (negative variation or action-current) is at once explained by assuming that at this time the membrane becomes freely permeable also to anions. Free permeability to ions during stimulation is indicated by the refractory period, as already pointed out. The increase in permeability following death or injury is accompanied by an electrical change similar to that associated with stimulation—a fact which

again supports the view that permeability is temporarily increased during stimulation.

5. A close inorganic parallel to certain characteristic phenomena of stimulation is seen in the pulsating mercury hydrogen peroxide catalysis of Bredig and his collaborators. The electrical rhythm accompanying the rhythm of oxygen-evolution has been shown by Antropoff to run parallel with the formation and dissolution of a surface-film of mercury peroxidate. Here we have apparently an actual instance of a rhythmical change of potential which is due to rhythmical alteration of a surface-film; the marked resemblance in time-relations and in other respects to many rhythmical processes in organisms supports the view that a similar surface-change is the basis of the electrical variations accompanying automatic rhythmical stimulation in living tissues. The alternate formation and dissolution of the film over the mercury surface would correspond respectively to the alternate decrease and increase of permeability in the living cells.

The following special observations and experiments, made chiefly during the past summer at Woods Hole, furnish, it is believed, strong confirmatory evidence of the truth of the above general view. The organisms used were the larvæ of the annelid *Arenicola cristata,* which are readily obtainable in large quantity at Woods Hole. These are bitrochal larvæ *ca.* 0.3 millimeters in length with three setigerous body-segments; they swim actively by their cilia, showing pronounced positive phototaxis, and have a well-developed muscular system; and the cells are remarkable for containing large quantities of a water-soluble yellow pigment. This substance serves as an index of increased permeability by diffusing at such times from the cells and coloring the medium; such loss of pigment occurs during intense stimulation, after death, or under the influence of cytolytic substances (chloroform, etc.), but not during the normal activities of the animal; the phenomenon indicates therefore an abnormally great increase of permeability.

When *Arenicola* larvæ are transferred from sea-water into pure isotonic solutions of various alkali and alkali-earth salts (*e. g.,* $NaCl$, KCl, NH_4Cl, $LiCl$, $CsCl$, $RbCl$, $SrCl_2$, $BaCl_2$) they contract strongly to almost half the normal length and remain contracted for several seconds. During this interval the yellow pigment diffuses freely from the cells and colors the solution. Isotonic $CaCl_2$ and $MgCl_2$, on the other hand, have no such intense stimulating action and cause no loss of pigment; in these solutions the larvæ remain straight and extended and muscular movements cease (anesthethic action). Addition of a little $CaCl_2$ (1 volume $m/2$ $CaCl_2$ to 24 volumes $m/2$ $NaCl$) to isotonic $NaCl$ solution prevents the initial stimulating action of the pure salt and at the same time the loss of pigment; in this mixed solution larvæ remain living and active for greatly prolonged periods (antitoxic action of Ca ions). Both the stimulating action and the toxicity of the pure sodium salt are thus associated with a marked increase of permeability; if this last is checked, as by the presence of appropriate bivalent cations (Ca, Mg, etc.), the two former effects also disappear. Solutions of $MgCl_2$ and similarly acting salts and anesthetics appear, on the contrary, to *decrease* the normal permeability. Stimulation is thus associated with an increase and inhibition with a decrease of permeability.

The electrolytes affect permeability presumably by influencing the state of aggregation of the colloids composing the plasma membrane. The consistency of the latter may also be changed by altering the condition of its lipoid constituents. It was found that relatively strong solutions of lipoid-solvents in sea-water, or even in $m/2MgCl_2$ solution (one half to one third saturated chloroform; saturated ether or benzole), also produce strong muscular contractions accompanied by loss of pigment. Solutions of this concentration are rapidly destructive to the larvæ; in *lower* concentrations the lipoid-solvents have the opposite action, checking activity (anesthetic action) without stimulation or loss of pigment. In general, the lipoid-solvents in *low* concentration appear to decrease permeability and hence temporarily to suspend activity without toxic action (anesthesia); in

higher concentrations they stimulate strongly, cause visible increase of permeability, and show pronounced toxicity. It would thus appear that marked increase of permeability, if prolonged for more than a short time, is highly injurious to cells—presumably on account of the diffusion of essential protoplasmic constituents to the exterior and the resulting chemical disorganization. Decrease of permeability, on the other hand, can have no such injurious effect, but merely checks interchange of material across the plasma membrane for the time being.

In isotonic sugar solutions muscular contractility is gradually lost. On transfer to solutions of various electrolytes contractions return. Of the pure solutions of the alkali salts the most favorable in restoring contractility are those of sodium; lithium and cæsium, while less favorable, resemble sodium in their general action; rubidium and potassium produce temporary contractions, but are much more toxic than the others. The order of increasing favorability for the cations is thus: K and Rb $<$ NH_4 $<$ Li $<$ Cs $<$ Na. The various sodium salts vary in their action according to the nature of the anion; the order of increasing favorability for anions is: I $<$ Br $<$ NO_3 (and ClO_3) $<$ Cl $<$ HPO_4 $<$ $C_4H_4O_6$ $<$ SO_4 $<$ $COOCH_3$. Of the alkali earth chlorides $MgCl_2$ produces no return of contractions; $CaCl_2$ and $SrCl_2$ cause slight contractions lasting some time; $BaCl_2$ almost immediately destroys all muscular contractility.

In explanation of the above effects it is assumed that in the non-electrolyte solution the normal permeability is decreased; hence the inhibitory or anesthetic action. The above electrolytes, by their action on the colloids of the plasma membrane, increase the permeability of the latter and so stimulate. On this interpretation, *any* substance which alters the plasma membrane in the direction of increased permeability should *ipso facto* restore contractility in larvæ from sugar-solution. It was found that weak solutions of acids (HCl, H_2SO_4, $HCOOCH_3$ in concentrations of $n/3{,}200$ to $n/12{,}800$) in isotonic sugar solutions restore almost normal contractions for a certain time. Acid causes also marked increase in the state of tonic muscular contraction. Alkali, on the other hand, has little power of restoring contractility, and induces decrease of muscular tone or lengthening. Weak acid thus appears to increase and alkali to decrease the permeability of the plasma membranes in larvæ from sugar solution.

Experiments on the influence of different electrolytes in restoring contractility in larvæ from isotonic $MgCl_2$ solution gave results essentially similar to the above, with the difference that the restorations of contractions by pure solutions of the above electrolytes is, as a rule, less readily effected. Presumably $MgCl_2$ solutions decrease the normal permeability to a greater degree than sugar; anesthesia appears more rapidly and is more profound in solutions of this salt than in those of dextrose or other sugar.

The question why increase of permeability should correspond to stimulation and decrease to inhibition is answered in essentially the following manner. It is assumed that during periods of increased permeability the loss of carbon dioxide from the cell will be more rapid than normal; the energy-yielding oxidative reactions of which this substance is the end-product are thus accelerated as a direct consequence of the increased rate of removal of the reaction-product from the system; hence the increased contractile activity or other energy manifestation during stimulation. Conversely, decrease of the normal permeability means decreased loss of carbon dioxide and hence retarded oxidation and energy-production; stimulation is more difficult at such times because of the greater difficulty of increasing the permeability to the critical degree required. This general view ascribes primary importance to the plasma membrane as probably the chief means by which the velocity of the oxidative energy-yielding reactions in the cell is varied. The promptness and vigor of the response to stimulation in highly irritable and active tissues like muscle are to be regarded simply as evidence of the high velocity with which the energy-yielding process, when unimpeded by the accumulation of reaction-products, proceeds in such cells. The grounds of this

high velocity are imperfectly understood at present. If we assume, however, that the reactions in the living cell progress rapidly to equilibria, and that in the resting cell, with a plasma membrane offering considerable resistance to the passage of CO_2, a condition of approximate chemical equilibrium prevails—it is clear that any disturbance of equilibrium, as by a more rapid removal of reaction-products (*i. e.*, CO_2), must be followed by a corresponding prompt acceleration of the reaction concerned. Such a system would respond to variations in the rate of removal of CO_2—*i. e.*, to variations in permeability—in a manner which under favorable conditions might well be very sensitive.

The *positive* electrical variation during inhibition (Gaskell)—as well as the negative during stimulation—receives consistent explanation on the membrane-theory if the polarizing electrolyte is assumed to be carbonic (with possibly other) acid. For further discussion the reader is referred to the complete paper in the *American Journal of Physiology*, Volume 24, April, 1909, page 14.

Ralph S. Lillie
Marine Biological Laboratory,
Woods Hole, Mass.,
June 15, 1909

THE FORTIETH GENERAL MEETING OF THE AMERICAN CHEMICAL SOCIETY

The fortieth general meeting of the American Chemical Society was held at the Detroit Central High School from Tuesday, June 29 to July 2, 1909. About 300 chemists were present, making this the most largely attended summer meeting in the history of the society.

On Tuesday evening the visiting chemists enjoyed a complimentary smoker given by the Detroit Society of Chemists.

On Wednesday afternoon and evening the visitors were guests of Parke, Davis & Co. In the afternoon the chemical laboratories were inspected and luncheon was served in the evening. This was followed by a moonlight ride on the river.

On Thursday morning a special train carried the visitors to Ann Arbor on the invitation of the regents of the University of Michigan. A subscription dinner was given at the Hotel Pontchartrain on Thursday evening.

On Friday excursions were made to the following manufacturing establishments: Acme Lead and Color Works, paints, white lead by new process; Morgan & Wright, auto tires and mechanical rubber; Detroit Salt Company, rock salt mine, 800 feet deep; Murphy Ice Company, distilled water, artificial ice—ozonizing plant in connection; Peoples' Ice Company, artificial ice plant; Packard Automobile Company; Detroit City Gas Company, manufacturers of illuminating gas; Cadillac Motor Car Company, auto manufacturers; The Herpicide Company; Goebel Brewing Company; Hiram Walker & Sons, distillery; American Electric Heater Company; Hoskins Manufacturing Company, pyrometers and electric furnaces; Sibley Quarry Company, limestone and sand-lime bricks; Peninsular Engraving Company, engravers and printers; The Clark Wireless Telegraphy Company, manufacturers of wireless equipment; Berry Brothers, varnish manufacturers; Detroit Iron and Steel Company, blast furnace.

The following papers were read before the general meeting:

Optical and Quartz Glass; their Chemical and Physical Properties: H. E. Howe.

The Chemistry of Phosphorescing Solids: Wilder D. Bancroft.

The following papers were read before the Section of Chemical Education:

A Place for Chemistry in the American College: Alexander Smith.

Some Ideals, Some Difficulties and a Compromise for a First Course in Chemistry: S. Lawrence Bigelow.

A First College Course in Chemistry: Arthur John Hopkins.

College Chemistry beyond the Elementary Course: Lauder W. Jones.

Laboratory Instruction in Industrial Chemistry: Harry McCormack.

Teaching by the Lecture System: Norman A. Dubois.

The following papers were read before the various sections:

BIOLOGICAL CHEMISTRY

Samuel C. Prescott, chairman

The Determination of Urea in Urine: F. W. Gill and H. S. Grindley.

This paper gave the results of a somewhat complete comparative study of the Folin, the Benedict-Gephart and the hydrolysis-aeration methods for the determination of urea. The following are the most important conclusions: First, creatinine and hippuric acid are not at all decomposed by heat-

ing in the autoclave with hydrochloric acid, but they are partially decomposed either before or after treatment with hydrochloric acid in the autoclave by distillation with 20 c.c. of 10 per cent. sodium hydroxide solution. Second, uric acid is decomposed in part by the autoclave treatment with hydrochloric acid and, moreover, it is still further decomposed into ammonia by distillataon with 20 c.c. of 10 per cent. sodium hydroxide solution. Third, the hydrolysis-aeration method purposed by the writers gives practically the same urea nitrogen values as does the Folin method, but the Benedict-Gephart method gives higher results than does the Folin method. The average of the analyses of twenty-five samples of urine in triplicate by the Folin method gave a value of 10.00 grams of urea nitrogen, while the hydrolysis-aeration method gave a value of 10.05 grams, and the Benedict-Gephart method gave a value of 10.25 grams of urea nitrogen per 24 hours. The results of the hydrolysis-aeration method expressed as percentage of the Folin results varied from 99.45 to 101.94 per cent., the average being 100.43 per cent. The results of the Benedict-Gephart method expressed as percentage of the Folin results varied from 100.88 to 103.86 per cent., the average being 102.52 per cent. Fourth, the hydrolysis-aeration method requires much less time and attention than does the Folin method and it does not require the expert manipulation and training necessary to get concordant results as does the Folin method.

Animal Nutrition. The Chemical Composition of the Wholesale Cuts of Beef from Three Animals: A. D. Emmett and H. S. Grindley.

This paper reported the results of the slaughter tests and the detailed chemical analysis of the regulation wholesale cuts of three steers and one calf. The four animals were of different ages and it was thus possible to determine the nature of the growth of the animal body at different stages of its development. From the analytical data obtained it was possible to calculate the weights of the following constituents: water; insoluble, soluble and total dry substance; insoluble, soluble and total protein; coagulable, non-coagulable and total soluble protein; nitrogenous, non-nitrogenous and total organic extractives; fat; insoluble, soluble and total mineral matter; and insoluble, soluble and total phosphorus—in the eleven wholesale cuts and the entire carcass of each of the four different animals.

The results clearly show that with an increase in the age of the animal there is a decrease in the percentage of the following constituents found in the animal body—water, soluble dry substance, soluble coagulable protein, soluble non-coagulable protein, total soluble protein, nitrogenous and non-nitrogenous extractives, and soluble phosphorus, but an increase in the percentage of the following constituents: total dry substance, fat, insoluble protein and insoluble phosphorus. A careful study of the data leads unmistakably to the conclusion that the cheaper cuts of meat in many instances have as high a food value as the more expensive ones. The cheaper cuts are just as wholesome, just as nutritious, and in every way just as good as the more expensive cuts, except that the latter give greater gratification to the palate. The data show that there are noticeable similarities and differences between animals of different age and breed—as to the weights of the bone, the visible fat, the lean meat and also as to the chemical composition of the edible flesh. The results of the chemical analysis indicate well-defined differences due to age and maturity, and marked differences between the wholesale cuts of a side of beef, and yet a noticeable similarity in the relative values of the corresponding wholesale cuts from different animals.

Urinary Creatinine of Men in Health: H. S. Grindley.

A study of the urinary creatinine of a group of 24 men in apparently normal health, varying in age from 18 to 31 years and ranging in weight from 54.0 to 80.1 kilograms, was made for a period of 220 days. A varied and mixed diet consisting of fruits, cereals, vegetables, soups, meats, bread, milk, cocoa and sugar was supplied the members of the club. The ingested nitrogen varied from 10.6 to 15.8, the average being 13.3 grams per man per day. The lowest average individual creatinine value of the 24 subjects for the entire period of 220 days equaled 1.58 grams per day. The highest average individual creatinine value for the entire group for the same period equaled 2.25 grams per day. The average creatinine value expressed as grams per 24 hours for the twenty-four men for a period of 220 days equaled 1.85 grams. The creatinine values in the form of the so-called creatinine coefficients, that is, as milligrams of creatinine per kilogram of body weight, are as follows: minimum 24.4, maximum 31.5, average 28.1.

Folin first proved the fact "that the absolute quantity of creatinine eliminated in the urine on a meat-free diet is a constant quantity different for different individuals, but wholly independent

of quantitative changes in the total amount of nitrogen eliminated." The fact that the amount of creatinine excreted in the urine by a normal individual is quite independent of the amount of protein in the food, or of the total nitrogen in the urine, has been verified by many investigators. On the other hand, it seems to me that it is still a question as to whether or not the absolute quantity of creatinine eliminated even on a meat-free diet is a constant quantity for the same individual. Examination of Folin's results shows that between the minimum and maximum creatinine values for the same individual of a group of six normal men, during a period of five days, there are differences of 0.09 to 0.28 gram of creatinine per 24 hours, which differences amount to 6.4 to 22.9, the average being 13.32 per cent. of the minimum creatinine values. Again, for a group of six normal men during periods ranging from 9 to 16 days there are differences of 0.17 to 0.45 gram of creatinine per 24 hours, which differences amount to 15.6 to 35.5, the average being 21.0 per cent. of the minimum creatinine values. Shaffer for two individuals during periods of 8 to 25 days found differences of 0.24 and 0.37 gram of creatinine per day, which equals 19.8 and 26.6 per cent. of the minimum creatinine values. These variations, it seems to me, can not be considered insignificant.

The individual variations in the creatinine for the 24 subjects of this investigation, upon a diet containing meat, during a period of 220 days range from 0.50 to 0.99 grams per 24 hours, which equals 30.1 to 73.8 per cent. of the minimum creatinine values. These variations are apparently caused in the main at least by variations in atmospheric temperature; as a rule, other conditions being the same, the lower the temperature the smaller is the excretion of creatinine, and *vice versa*. The author is indebted to Professor A. P. Mathews, of Chicago University, for valuable suggestions in connection with this work.

A Study of the Food Requirements of a Group of Twenty-four Men: H. S. GRINDLEY and H. H. MITCHELL.

The detailed food requirements of a group of 24 men in apparently normal health, varying between 18 to 31 years of age and ranging between 54.0 and 80.1 kilograms in weight were accurately determined for a period of 220 days. A proper variety in diet, and, at the same time, a reasonable regularity in protein, carbohydrate and fat intake were secured by employing a carefully arranged eight-day menu. The protein actually consumed per individual varied from 67 to 99, the average for the 24 subjects being 85 grams per man per day. The grams of protein per kilogram of body weight varied from 1.11 to 1.44, the average for the 24 men being 1.28.

The maximum protein value of 99 grams obtained in this investigation is somewhat below the so-called Voit and Atwater standards of 100 grams for people doing light muscular work, but the average value of 85 grams is decidedly above any of the so-called minimum values of Chittenden, while the minimum value of 67 grams which is for a very light man weighing only 56 kilograms or 123 pounds compares closely with Chittenden's minimum values of 63 to 67 grams for men weighing upon an average 70 kilograms or 154 pounds.

The fuel value varied per individual from 2,584 to 3,685, the average for the entire group being 3,135 calories per day. The calories per kilogram of body weight ranged from 41 to 54, the average being 47. The carbohydrates actually consumed varied from 315 to 441, the average being 380 grams per man per day. The fat eaten varied from 94 to 192, the average being 131 grams per man per day.

Composition of the Fat of Beef Animals on Different Planes of Nutrition (first paper): C. R. MOULTON and P. F. TROWBRIDGE.

Fifteen to twenty fat samples from each of nine steers were investigated for moisture, fat and protein content, iodine value, saponification value and melting point. In the fatty tissue a high per cent. of fat is accompanied by a low per cent. of moisture and protein. The fat in the fatty tissue increases with fatness, the moisture with leanness. The fat per cent. in the fatty tissue increases from outside to inside while the moisture decreases. The iodine value of the fat increases with age, fatness and distance from the inside of the body, while the melting point falls.

Changes in the Composition of the Skeleton of Beef Animals (first paper): P. F. TROWBRIDGE and F. W. WOODMAN.

Seven steers were selected, all of nearly the same age and breed. They were fed to a good fat condition and one was killed as a check (when one year old). The others were put on the same rations (corn chop, linseed meal and alfalfa), varying in quantity so that two of the animals were on submaintenance, losing one half pound in weight daily. Two on maintenance and two on supermaintenance, gaining one half pound daily. One of each group was slaughtered after six months, the second submaintenance after eleven

months and the second maintenance animal after one year. Nine separate samples of the skeleton of each animal were analyzed. The results show that the principal effect of poor nutrition upon the skeleton is the removal of fat and its replacement with water, and that this effect is shown only after the fat is practically all removed from all other parts of the body. The mineral matter is practically unaffected by a long period of poor nutrition, and the same is true of the organic matter other than fat.

The Glycogen Content of Beef Flesh (first paper): P. F. Trowbridge and C. K. Francis.

The glycogen in the liver of beef animals is found as high as 3.8 per cent.; in the lean fresh muscle not to exceed two thirds of one per cent. The older animals show more glycogen than do the younger. Enzymatic hydrolysis of the glycogen takes place rapidly and probably accounts for much of the discrepancy of results. At 10° C. or less the enzymatic hydrolysis does not take place.

The Determination of Phosphorus in Flesh (first paper): P. F. Trowbridge.

A comparison of the amounts of phosphorus found in flesh by ignition to an ash and by digestion with sulphuric acid shows the same results by both methods. Phosphorus is not lost by ignition of flesh to an ash in open crucibles.

The following paper was reported by title:

A Review of Methods for the Estimation of Fat in Tissues: Waldemar Koch.

AGRICULTURAL AND FOOD CHEMISTRY

W. D. Bigelow, chairman

W. D. B. Penniman, secretary

Analysis of Citrous Oils: E. M. Chace and H. S. Bailey.

The principal constituents of oil of orange and oil of lemon, and their relative proportion in these oils, are briefly discussed. A short review of the present analytical methods applied to citrous oils for the purpose of detecting the more common adulterants is given. Owing to the increasing tendency to adulterate these oils with their own terpenes, the by-products from the manufacturer of the terpeneless oils and terpeneless extracts, it has become very important that we have some method for the detection of additions of these terpenes to normal oils. With this object in view, the vacuum distillation method has been employed and special apparatus constructed whereby it is possible to distill by means of the electric current 90 per cent. of the oil. The usual typical constituents of the original oil, when compared with those of the residual 10 per cent., have proved themselves valuable guides in the detection of these terpene bodies. A large number of authentic samples have been analyzed and work on the commercial oils of the country is now in progress. The exact data and results of these later investigations will be published at some future time.

The Distillation of Whisky: A. B. Adams.

Samples from different parts of a day's run were taken at two distilleries, one in Pennsylvania, where a three-chambered charge still is used for the distillation of the beer, and one in Kentucky, where the twelve or more chambered continuous beer still is operated. Samples of the beer, exhausted beer, of the leeswater and others representative of the different fractions of the distillation of the first and second distillations were analyzed. The results show that there is practically no fractionation in the distillation of whisky as practised in this country. It being shown that the product is separated into only two portions, first the distillate, second the exhausted beer or leeswater in the second still. The results prove that with the exception of a certain per cent. of acids and esters practically nothing is eliminated in the exhausted beer or leeswater. It was also evident that certain chemical changes occur in the acids, esters and aldehydes during the distillation.

A Volumetric Method for the Determination of Casein: L. L. Van Slyke and Alfred W. Bosworth.

To 20 c.c. of milk in a 200 c.c. flask, one adds about 80 c.c. of water and 1 c.c. of phenolphthalein solution. Then $n/10$ caustic soda is run into the diluted milk until a faint but distinct pinkish color remains after vigorous shaking. One then runs from a burette into the mixture $n/10$ $HC_2H_3O_2$, 5 c.c. at a time, shaking vigorously after each addition. The acid is run in until the casein separates promptly in large-sized flakes, leaving a clear supernatant liquid. It is best to have the mixture at a temperature of 65° to 75° F. before running in acid. Under these conditions, 30 c.c. of acid precipitates the casein in most milks. In some cases, only 25 c.c. may be required, while in some rare cases we have used 35 to 40 c.c. A few c.c. of acid in excess does not affect results. After precipitation of casein is complete, the mixture is diluted to the 200 c.c. mark, shaken vigorously ten or fifteen seconds and then filtered through a dry filter. The filtrate

should be clear. One takes 100 c.c. of the filtrate and from a burette adds $n/10$ NaOH until the neutral point is reached. The presence of phosphates may tend to obscure somewhat the end-point, but a little care enables one to get within a drop of the neutral point. The percentage of casein is calculated from the obtained results as follows: Divide the number of cubic centimeters of acid used by 2, subtract from this the number of cubic centimeters of alkali used to neutralize 100 c.c. of filtrate and multiply the result by 1.096. By using 22 c.c. of milk, the difference between one half of acid and of the alkali gives percentage directly without multiplying by a factor. The method gives satisfactory results when carried out with proper care. A determination can be completed in twelve to fifteen minutes, a half dozen or more can be made in about forty-five minutes when all conveniences are at hand and the manipulations are well under control.

The Determination of Nitrates in Potable Waters with High Chloride Content: J. Pearce Mitchell.

The conditions most favorable for the use of the "phenol-sulphonic acid method" were found to be: care in preventing evaporation of sample to complete dryness in the water-bath, prompt addition of the acid, use of an excess of acid (1.5 c.c. at least), and allowance of time for the completion of the reaction with the acid before dilution. Standards prepared according to Mason's suggestion gave the best results. With the reduction method the Cu-M couple in the presence of an excess of oxalic acid (0.5 g. per 100 c.c. of sample) was used. Reduction was complete in fourteen hours. The NH_3 is best determined by distillation, and nesslerization of the distillate. In the case of very high nitrate content the distillate is better collected in a standard acid solution. From laboratory experiments with solutions of known concentrations, and from the analysis of fifty-one samples of natural water by both methods, it appeared that the reduction method gave the better results with low nitrate content.

The procedure recommended is to use the reduction method for routine work; if the nitrate content is found to exceed five parts per million to repeat the determination, using the "phenol-sulphonic acid" method and, if the chlorides exceed ten parts per million, standards prepared according to Mason's suggestion.

The Normal Chloride Content of the Surface Waters on the San Francisco Peninsula: J. Pearce Mitchell.

From an area of 650 square miles 250 samples were collected at different seasons from 126 points. High chloride content, as compared with eastern waters, and wide local variations were found. Actual values varied from 9 to 50 parts per million in unpolluted streams. Discussion of the general climatic conditions, rainfall and ocean winds as factors leading to high values. Consideration of the topography, character of vegetation, exposure to ocean winds and wide local variations in rainfall (15–50 inches) as factors producing great local variations in normal chloride values. Emphasis of importance of study of local conditions, determination of local standards, and need of caution in interpretation of analysis from regions not investigated.

The Relation between the Calcium and the Fat Content of Cream: Hermann C. Lythgoe and Clarence E. Marsh.

This work was undertaken with the view of finding the maximum amount of calcium present in cream beyond which adulteration could be declared. The samples used were known purity samples, the cows having been milked and the cream separated in the presence of an inspector or analyst of the Massachusetts State Board of Health, samples separated from milk collected by the inspectors, and commercial samples found free from sugar by the Baier & Neumann reaction.

The calcium was found to decrease as the fat increased and the figures were plotted. From the plot the following results were taken:

Fat Per Cent.	CaO Minimum Per Cent.	CaO Maximum Per Cent.
50	0.057	0.092
45	0.070	0.103
40	0.082	0.117
35	0.095	0.130
30	0.107	0.142
25	0.119	0.154
20	0.132	0.168
15	0.144	0.180
10	0.156	0.192

The Determination of Benzoic Acid in Food Products: Edmund Clark.

The method proposed for the determination of benzoic acid consists in utilizing both ether and chloroform as extractive agents as follows: An aliquot portion of the filtrate, obtained by filtering a weighed amount of the substance which has been mixed with water and made up to a definite volume, is acidified with HCl and shaken out with

three 100 c.c. portions of ether. The unwashed ether extract is distilled rapidly over steam or by electric stove to the volume of about 5 c.c. and the residue exhausted by a current of air. This extract is dissolved in a little alkaline water and, after transferring to a Squibb separator and acidifying with hydrochloric acid, is shaken out with 40, 30, 20 and 10 c.c. successive portions of chloroform. The chloroform extract is washed with 30 c.c. water and transferred to a suitable container to which is added 100 c.c. recently boiled water and a few drops of phenol-phthalein.

The mixture is then titrated with N/20 NaOH, shaking well after each addition of alkali. Each cubic centimeter of N/20 used has a benzoic acid value of .0061. A correction is made for blank chloroform water mixture. The necessity for using ether will not arise when chloroform will readily make the extraction.

The advantages of the method are as follows: First, economy in time and in recovery of solvents; second, avoidance of tenacious chloroform emulsions; third, interfering organic acids eliminated; fourth, loss of benzoic acid reduced to a minimum.

The Determination of Sucrose and Lactose in Sweetened Chocolate: W. D. BIGELOW and M. C. ALBRECH.

The method is proposed to obviate the difficulties ordinarily experienced in the extraction of fat preliminary to the determination of sugar and in the volume of the lead precipitate. A normal weight of the sample (26 grams per Ventske instrument) is placed in a 100 c.c. sugar flask, 90 c.c. of water added and the flask heated with occasional shaking in a water-bath. After the air in the flask is heated a stopper is inserted. When the temperature has reached 70 or 80°, 10 c.c. of basic lead acetate is added and the flask thoroughly shaken and allowed to cool. The mixture is then filtered and the clear liquid polarized and its specific gravity taken. From a table the amount of sucrose is read off from the polarization alone. In the presence of lactose the solution is inverted and again polarized, this time at 86°.

Composition and Treatment of Lake Michigan Water: EDWARD BARTOW and LEWIS I. BIRDSALL.

A zone of pollution has been found to extend into Lake Michigan along the shore of Indiana and Illinois. All communities are not able to extend their water intakes beyond this zone of pollution or to divert their sewage as Chicago does. Filtration must be used to get a pure water. The average composition of the water was determined and experiments made to learn the action of various coagulents that may be used in connection with mechanical filtration.

Lime, sulphate of aluminum, sulphate of iron and sodium carbonate were used either alone or in combination.

The results showed the best results with sulphate of aluminum were obtained when 2½ grains per gallon were used. Two grains of lime could be substituted for one grain of sulphate of aluminum at a saving of $1.34 per million gallons. Sulphate of iron could replace the sulphate of aluminum at a further saving of $1.08 per million gallons. Special care must be taken, however, when lime or sulphate of iron is used.

The Examination of Dried Fish: B. H. SMITH.

Cusk and haddock are often substituted for cod in boneless and shredded so-called "codfish" because of their low price and because the preparations made from these fish resemble those of cod, making the detection of the substitution a matter of some difficulty. Hake and pollock are less frequently used, primarily because the reddish color of the former and the brownish color of the latter indicate the presence of these fish.

In an attempt to differentiate chemically the several varieties of closely allied salted fish the body oils were extracted by means of carbontetrachloride from desiccated ground samples, representing, in the case of cod, variations of geographical origin and methods of curing, and the iodin number, the refractive index, and, in some instances, other determinations, were made. The iodin numbers in all cases were lower than those of the liver oils of the same variety of fish and even greater variability was evidenced. The results obtained by the Hanus method on the cod samples varied from 85 to 137, which wide range is believed to be due in part to the complex composition of the natural oil and in part to the oxidizing influence of the salting and drying process; the cod substitutes gave iodin numbers of from 112 to 120.

The refractive indices of the oils from the cod samples varied from 1.5020 to 1.5043 at 25°, and those of the other varieties of fish from 1.4890 to 1.5000 at the same temperature. The "reducing substances" of the fish, which were determined by the method of Williams, *Journal of Chemical Society*, LXXI., 649, who reported considerable variation in different varieties, were found in but small amounts and are apparently

without significance. The microscopical examination of the fiber promises little because of the variation in the fiber in fish of different sizes, and also in different parts of the fish.

Determination of Caffein in Coffee: A Comparison of the Hilger and Fricke Method with a Modification of the Gomberg Method: A. L. Sullivan.

Five grams of coffee were boiled with four separate portions of water; the combined filtrate treated with 5 c.c. of saturated lead acetate, filtered and washed and the filtrate freed from lead by means of hydrogen sulfide. The solution was evaporated to about 25 c.c., cooled and extracted in a separatory funnel successively with 50, 25, 25, 25 c.c. of chloroform. The combined chloroform extract was freed from chloroform and dissolved in about 25 c.c. of water ½ c.c. (1–5 H_2SO_4) and 20 to 25 c.c. approximately N/10 iodine solution added. The precipitate formed immediately and was allowed to stand for two hours. The solution was then filtered and washed with a dilute acidified solution of iodine (1 part N/10 iodine to 4 of water). The precipitate after standing for a few minutes was dissolved in sulphurous acid and water. The solution was heated until the iodine was driven off, allowed to cool and made slightly alkaline with ammonia. The volume should be about 25 c.c. The solution was again extracted with chloroform, using the same amount as before. The chloroform extract was then evaporated in a tared dish, dried in a water oven and weighed.

It was found that the extraction of caffein from its aqueous solution by chloroform was practically complete.

The results seem satisfactory and it is apparent that the method described is suitable for determination of caffein in coffee. The results are slightly higher than those obtained by the A. O. A. C. method.

The Relation of the Iron Content to the Color of Soils: F. K. Cameron and W. O. Robinson.

A chemical examination of twenty typical red and yellow soils shows that iron oxides are the inorganic coloring matter of these soils. Manganese is present in amounts too small to contribute to the color.

The causes in color variations of iron-colored soils is sometimes ascribed to the presence of different hydrates of iron oxide. From the comparatively small variation in soil temperature in near localities where the two tints are present it is reasoned that this view is incorrect, and that the iron is in much the same state of hydration.

The color is shown to be due to a film of oxides of iron and aluminum, organic matter, silica, etc., surrounding the soil grains. By comparing the color of soils with the iron content and mechanical analysis, it is proved that the thickness of the film causes the variations in color, the thin film of the colored oxide causing the soil to appear yellow, while a thicker film gives a red shade to the soil. This view was confirmed by precipitating ferric hydroxide upon sands of different-sized grains and upon quartz flour, using such amounts as to keep the percentage of iron constant and vary the thickness of the film.

The following papers were reported by title:

A Chemical Study of the Interaction of Fermenting Manures and Ground Rock Phosphate: E. V. McCollum and W. E. Tottingham.

The Estimation of Organic Matter in Soils: G. H. Failyer and W. H. Waggaman.

The Relation of Moisture Content to the Heat Conductance of Soils: H. E. Patten.

The Element System of Nomenclature in Soil Chemistry: C. G. Hopkins.

The Interpretation of Soil Analyses with Respect to Phosphoric Acid: G. S. Fraps.

The Potash of the Soil: G. S. Fraps.

The Oxidation of Organic Matter in the Soil: G. S. Fraps and N. C. Hamner.

The Constants of Pecan Oil: G. S. Fraps.

The Hydrolysis of Salicyn by the Enzyme Emulsion: C. S. Hudson.

No abstracts have been received for papers read before the sections of Fertilizer Chemistry, and the Industrial Chemists and Chemical Engineers. The titles follow:

FERTILIZER CHEMISTRY SECTION

F. B. Carpenter, chairman
J. E. Breckenridge, secretary

Potash Tests in Commercial Fertilizer: J. E. Breckenridge.

The Measurement of Crude Sulphuric Acid: F. B. Porter.

The Corrosive Action of Alkaline Tank Water upon an Evaporation and a Remedy: R. H. Fash.

The Use of Wood Ashes in Commercial Fertilizers: R. H. Fash.

Preparation and Neutralization of the Ammonium Citrate Solution: J. M. McCandless.

The Needs of Texas Soils for Fertilizers: G. S. Fraps.

The Scientific Preparation of Phosphate Samples for Chemical Analysis: P. D. Youngblood.

The Effect on Insoluble Phosphoric Acid when Litmus, Corallin and Cochineal are used in Preparing Solution of Ammonium Citrate: G. A. Farnham.

The Availability of Certain Nitrogenous Manures: Burt L. Hartwell.

Moisture in Phosphate Rock of the Pacific: Carlton C. Jones.

INDUSTRIAL CHEMISTS AND CHEMICAL ENGINEERS

A. D. Little, chairman

B. T. B. Hyde, secretary

Limitations of Use of Starch as an Accelerator in the Fusion Method: C. K. Francis.

The Technical Determination of Caoutchouc in Guayule: Charles P. Fox.

Laboratory Reagents and C. P. Chemicals: Clarence Riegel.

Standard Hydrometers: Louis A. Fischer and N. S. Osborne.

The Temperature Work of the Bureau of Standards: C. W. Waidner.

On the Influence of the Temperature of Burning on the Rate of Hydration of Magnesium Oxide: Edward DeMille Campbell.

The Electrotitrimeter: H. P. Bishop.

The Present Status of the Chemistry of India Rubber: W. C. Geer.

Free Lime in Portland Cement—A Mill Study: Arthur G. Smith.

The Inspection of Material: J. E. Moore.

Bag-house Treatment of Blast Furnaces and Roaster Gases: W. C. Ebaugh.

Hygienic Significance of Sulphur in Illuminating Gas: F. E. Gallagher.

The Destructive Distillation of Coals for Illuminating Gas: An Experimental Study: Alfred H. White.

The Determination of Fat and Soap in Sewage and Sewage Effluents: L. P. Kinnicutt.

Observations upon the Direct Determination of Carbon in Various Steels: G. W. Sargent.

Determination of Nitrates in Potable Water: Robert Spurr Weston.

The Ash of Coal and Its Relation to Actual or Unit Coal Values: S. W. Parr and W. F. Wheeler.

The Analysis of Asphalt and Asphaltic Compounds: S. W. Parr, Brainerd Mears and D. L. Weatherhead.

A Series of Parallel Determinations with the Mahler and Parr Calorimeters: S. W. Parr and W. F. Wheeler.

Further Application of the Specific Gravity Method for Determining Fat: Chas. H. Herty and E. J. Newell.

Some New Extractives for Use in Determining Fats: Chas. H. Herty.

Some Technical Applications of Titanium: Isador Ladoff.

The New Brady Gas Apparatus: William Brady.

A New Oil Gas Producer: A. B. Davis.

Manganese in Steel—a note: A. Auchy.

The Analysis of Lead Arsenate for Water Soluble Impurities: Roger C. Griffin.

The Bouquet of Wine and Beer: N. H. Claussen.

The Importance of Pedigree Cultures of Barley for Brewing Purposes: A. Nilson.

The Decomposition of Calcium Carbonate by Steam: Warren K. Lewis.

The Structure of Tin Plate as Determined by its Method of Manufacture: Wm. H. Walker and Warren K. Lewis.

Paint and Varnish Coatings as Accelerators in the Corrosion of Metals: Wm. H. Walker and Warren K. Lewis.

Convenient Illuminator for the Microscopic Examination of Opaque Objects: Wirt Tassin.

Copper-clad Steel—A Recent Metallurgical Product: Wirt Tassin.

A Simplified Combustion Crucible: P. W. Shimer.

Note on a Convenient Condenser for Extractions: David Bloom.

Barium and Sulphur in Fluorspar: H. G. Martin.

Cyanidation of Silver Minerals: Theo. P. Holt.

The Preparation of Sodium Oxalate for Use in Standardizing: John T. Baker.

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SCIENCE

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ADDRESS OF THE PRESIDENT OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE[1]

TWENTY-FIVE years ago a great change was made in the practise of the British Association. From the foundation of our society until 1884 its meetings had always been held in the British Isles; in that year, however, the association met in Montreal, and a step was taken which changed us from an insular into an imperial association. For this change, which now I think meets with nothing but approval, Canada is mainly responsible. Men of science welcome it for the increased opportunities it gives them of studying under the most pleasant and favorable conditions different parts of our empire, of making new friends; such meetings as these not only promote the progress of science, but also help to strengthen the bonds which bind together the different portions of the king's dominions.

This year, for the third time in a quarter of a century, we are meeting in Canada. As if to give us an object lesson in the growth of empire, you in Winnipeg took the opportunity at our first meeting in Canada in 1884 to invite our members to visit Manitoba and see for themselves the development of the province at that time. Those who were fortunate enough to be your guests then as well as now are confronted with a change which must seem to them unexampled and almost incredible. Great cities have sprung up, immense areas have been converted from prairies to prosperous farms, flourishing industries have been started, and the population has quad-

[1] Winnipeg, 1909.

rupled. As the president of a scientific association I hope I may be pardoned if I point out that even the enterprise and energy of your people and the richness of your country would have been powerless to effect this change without the resources placed at their disposal by the labors of men of science.

The eminence of my predecessors in the chair at the meetings of the British Association in Canada makes my task this evening a difficult one. The meeting at Montreal was presided over by Lord Rayleigh, who, like Lord Kelvin, his colleague in the chair of Section A at that meeting, has left the lion's mark on every department of physics, and who has shown that, vast as is the empire of physics, there are still men who can extend its frontiers in all of the many regions under its sway. It has been my lot to succeed Lord Rayleigh in other offices as well as this, and I know how difficult a man he is to follow.

The president of the second meeting in Canada—that held in 1897 at Toronto—was Sir John Evans, one of those men who, like Boyle, Cavendish, Darwin, Joule and Huggins, have, from their own resources and without the aid derived from official positions or from the universities, made memorable contributions to science: such men form one of the characteristic features of British science. May we not hope that, as the knowledge of science and the interest taken in it increase, more of the large number of men of independent means in our country may be found working for the advancement of science, and thereby rendering services to the community no less valuable than the political, philanthropic and social work at which many of them labor with so much zeal and success?

I can, however, claim to have some experience of, at any rate, one branch of Canadian science, for it has been my privilege to receive at the Cavendish Laboratory many students from your universities. Some of these have been holders of what are known as the 1851 scholarships. These scholarships are provided from the surplus of the Great Exhibition of 1851, and are placed at the disposal of most of the younger universities in the British Empire, to enable students to devote themselves for two or three years to original research in various branches of science. I have had many opportunities of seeing the work of these scholars, and I should like to put on record my opinion that there is no educational endowment in the country which has done or is doing better work.

I have had, as I said, the privilege of having as pupils students from your universities as well as from those of New Zealand, Australia and the United States, and have thus had opportunities of comparing the effect on the best men of the educational system in force at your universities with that which prevails in the older English universities. Well, as the result, I have come to the conclusion that there is a good deal in the latter system which you have been wise not to imitate. The chief evil from which we at Cambridge suffer and which you have avoided is, I am convinced, the excessive competition for scholarships which confronts our students at almost every stage of their education. You may form some estimate of the prevalence of these scholarships if I tell you that the colleges in the University of Cambridge alone give more than £35,000 a year in scholarships to undergraduates, and I suppose the case is much the same at Oxford. The result of this is that preparation for these scholarships dominates the education of the great majority of the cleverer boys who come to these universities, and indeed in some quarters it seems to be held that the chief duty of a schoolmaster, and the

best test of his efficiency, is to make his boys get scholarships. The preparation for the scholarship too often means that about two years before the examination the boy begins to specialize, and from the age of sixteen does little else than the subject, be it mathematics, classics, or natural science, for which he wishes to get a scholarship; then, on entering the university, he spends three or four years studying the same subject before he takes his degree, when his real life work ought to begin. How has this training fitted him for this work? I will take the case in which the system might perhaps be expected to show to greatest advantage, when his work is to be original research in the subject he has been studying. He has certainly acquired a very minute acquaintance with his subject—indeed, the knowledge possessed by some of the students trained under this system is quite remarkable, much greater than that of any other students I have ever met. But though he has acquired knowledge, the effect of studying one subject, and one subject only, for so long a time is too often to dull his enthusiasm for it, and he begins research with much of his early interest and keenness evaporated. Now there is hardly any quality more essential to success in research than enthusiasm. Research is difficult, laborious, often disheartening. The carefully designed apparatus refuses to work, it develops defects which may take months of patient work to rectify, the results obtained may appear inconsistent with each other and with every known law of nature, sleepless nights and laborious days may seem only to make the confusion more confounded, and there is nothing for the student to do but to take for his motto "It's dogged as does it," and plod on, comforting himself with the assurance that when success does come, the difficulties he has overcome will increase the pleasure—one of the most exquisite men can enjoy—of getting some conception which will make all that was tangled, confused and contradictory clear and consistent. Unless he has enthusiasm to carry him on when the prospect seems almost hopeless and the labor and strain incessant, the student may give up his task and take to easier, though less important, pursuits.

I am convinced that no greater evil can be done to a young man than to dull his enthusiasm. In a very considerable experience of students of physics beginning research, I have met with more—many more—failures from lack of enthusiasm and determination than from any lack of knowledge or of what is usually known as cleverness.

This continual harping from an early age on one subject, which is so efficient in quenching enthusiasm, is much encouraged by the practise of the colleges to give scholarships for proficiency in one subject alone. I went through a list of the scholarships awarded in the University of Cambridge last winter, and, though there were 202 of them, I could only find three cases in which it was specified that the award was made for proficiency in more than one subject.

The premature specialization fostered by the preparation for these scholarships injures the student by depriving him of adequate literary culture, while when it extends, as it often does, to specialization in one or two branches of science, it retards the progress of science by tending to isolate one science from another. The boundaries between the sciences are arbitrary, and tend to disappear as science progresses. The principles of one science often find most striking and suggestive illustrations in the phenomena of another. Thus, for example, the physicist finds in astronomy that effects he has observed in the laboratory are illustrated on the grand scale in

the sun and stars. No better illustration of this could be given than Professor Hale's recent discovery of the Zeeman effect in the light from sunspots; in chemistry, too, the physicist finds in the behavior of whole series of reactions illustrations of the great laws of thermodynamics, while if he turns to the biological sciences he is confronted by problems, mostly unsolved, of unsurpassed interest. Consider for a moment the problem presented by almost any plant—the characteristic and often exquisite detail of flower, leaf and habit—and remember that the mechanism which controls this almost infinite complexity was once contained in a seed perhaps hardly large enough to be visible. We have here one of the most entrancing problems in chemistry and physics it is possible to conceive.

Again the specialization prevalent in schools often prevents students of science from acquiring sufficient knowledge of mathematics; it is true that most of those who study physics do some mathematics, but I hold that, in general, they do not do enough, and that they are not as efficient physicists as they would be if they had a wider knowledge of that subject. There seems at present a tendency in some quarters to discourage the use of mathematics in physics; indeed, one might infer, from the statements of some writers in quasi-scientific journals, that ignorance of mathematics is almost a virtue. If this is so, then surely of all the virtues this is the easiest and most prevalent.

I do not for a moment urge that the physicist should confine himself to looking at his problems from the mathematical point of view; on the contrary, I think a famous French mathematician and physicist was guilty of only slight exaggeration when he said that no discovery was really important or properly understood by its author unless and until he could explain it to the first man he met in the street.

But two points of view are better than one, and the physicist who is also a mathematician possesses a most powerful instrument for scientific research with which many of the greatest discoveries have been made; for example, electric waves were discovered by mathematics long before they were detected in the laboratory. He has also at his command a language clear, concise and universal, and there is no better way of detecting ambiguities and discrepancies in his ideas than by trying to express them in this language. Again, it often happens that we are not able to appreciate the full significance of some physical discovery until we have subjected it to mathematical treatment, when we find that the effect we have discovered involves other effects which have not been detected, and we are able by this means to duplicate the discovery. Thus James Thomson, starting from the fact that ice floats on water, showed that it follows by mathematics that ice can be melted and water prevented from freezing by pressure. This effect, which was at that time unknown, was afterwards verified by his brother, Lord Kelvin. Multitudes of similar duplication of physical discoveries by mathematics could be quoted.

I have been pleading in the interests of physics for a greater study of mathematics by physicists. I would also plead for a greater study of physics by mathematicians in the interest of pure mathematics.

The history of pure mathematics shows that many of the most important branches of the subject have arisen from the attempts made to get a mathematical solution of a problem suggested by physics. Thus the differential calculus arose from attempts to deal with the problem of moving bodies. Fourier's theorem resulted from

attempts to deal with the vibrations of strings and the conduction of heat; indeed, it would seem that the most fruitful crop of scientific ideas is produced by cross-fertilization between the mind and some definite fact, and that the mind by itself is comparatively unproductive.

I think, if we could trace the origin of some of our most comprehensive and important scientific ideas, it would be found that they arose in the attempt to find an explanation of some apparently trivial and very special phenomenon; when once started the ideas grew to such generality and importance that their modest origin could hardly be suspected. Water vapor we know will refuse to condense into rain unless there are particles of dust to form nuclei; so an idea before taking shape seems to require a nucleus of solid fact round which it can condense.

I have ventured to urge the closer union between mathematics and physics, because I think of late years there has been some tendency for these sciences to drift apart, and that the workers in applied mathematics are relatively fewer than they were some years ago. This is no doubt due to some extent to the remarkable developments made in the last few years in experimental physics on the one hand and in the most abstract and metaphysical parts of pure mathematics on the other. The fascination of these has drawn workers to the frontiers of these regions who would otherwise have worked nearer the junction of the two. In part, too, it may be due to the fact that the problems with which the applied mathematician has to deal are exceedingly difficult, and many may have felt that the problems presented by the older physics have been worked over so often by men of the highest genius that there was but little chance of any problem which they could have any hope of solving being left.

But the newer developments of physics have opened virgin ground which has not yet been worked over and which offers problems to the mathematician of great interest and novelty—problems which will suggest and require new methods of attack, the development of which will advance pure mathematics as well as physics.

I have alluded to the fact that pure mathematicians have been indebted to the study of concrete problems for the origination of some of their most valuable conceptions; but though no doubt pure mathematicians are in many ways very exceptional folk, yet in this respect they are very human. Most of us need to tackle some definite difficulty before our minds develop whatever powers they may possess. This is true for even the youngest of us, for our school boys and school girls, and I think the moral to be drawn from it is that we should aim at making the education in our schools as little bookish and as practical and concrete as possible.

I once had an illustration of the power of the concrete in stimulating the mind which made a very lasting impression upon me. One of my first pupils came to me with the assurance from his previous teacher that he knew little and cared less about mathematics, and that he had no chance of obtaining a degree in that subject. For some time I thought this estimate was correct, but he happened to be enthusiastic about billiards, and when we were reading that part of mechanics which deals with the collision of elastic bodies I pointed out that many of the effects he was constantly observing were illustrations of the subject we were studying. From that time he was a changed man. He had never before regarded mathematics as anything but a means of annoying innocent undergraduates; now, when he saw what important results it could obtain, he became en-

thusiastic about it, developed very considerable mathematical ability, and, though he had already wasted two out of his three years at college, took a good place in the mathematical tripos.

It is possible to read books, to pass examinations without the higher qualities of the mind being called into play. Indeed, I doubt if there is any process in which the mind is more quiescent than in reading without interest. I might appeal to the widespread habit of reading in bed as a prevention of insomnia as a proof of this. But it is not possble for a boy to make a boat or for a girl to cook a dinner without using their brains. With practical things the difficulties have to be surmounted, the boat must be made watertight, the dinner must be cooked, while in reading there is always the hope that the difficulties which have been slurred over will not be set in the examination.

I think it was Helmholtz who said that often in the course of a research more thought and energy were spent in reducing a refractory piece of brass to order than in devising the method or planning the scheme of campaign. This constant need for thought and action gives to original research in any branch of experimental science great educational value even for those who will not become professional men of science. I have had considerable experience with students beginning research in experimental physics, and I have always been struck by the quite remarkable improvement in judgment, independence of thought and maturity produced by a year's research. Research develops qualities which are apt to atrophy when the student is preparing for examinations, and, quite apart from the addition of new knowledge to our store, is of the greatest importance as a means of education.

It is the practise in many universities to make special provision for the reception of students from other universities who wish to do original research or to study the more advanced parts of their subject, and considerable numbers of such students migrate from one university to another. I think it would be a good thing if this practise were to extend to students at an earlier stage in their career; especially should I like to see a considerable interchange of students between the universities in the mother country and those in the colonies.

I am quite sure that many of our English students, especially those destined for public life, could have no more valuable experience than to spend a year in one or other of your universities, and I hope some of your students might profit by a visit to ours.

I can think of nothing more likely to lead to a better understanding of the feelings, the sympathies, and, what is not less important, the prejudices, of one country by another, than by the youths of those countries spending a part of their student life together. Undergraduates as a rule do not wear a mask either of politeness or any other material, and have probably a better knowledge of each other's opinions and points of view—in fact, know each other better than do people of riper age. To bring this communion of students about there must be cooperation between the universities throughout the empire; there must be recognition of each other's examinations, residence and degrees. Before this can be accomplished there must, as my friend Mr. E. B. Sargant pointed out in a lecture given at the McGill University, be cooperation and recognition between the universities in each part of the empire. I do not mean for a moment that all universities in a country should be under one government. I am a strong believer in the individuality of universities, but I do not

think this is in any way inconsistent with the policy of an open door from one university to every other in the empire.

It has usually been the practise of the president of this association to give some account of the progress made in the last few years in the branch of science which he has the honor to represent.

I propose this evening to follow that precedent and to attempt to give a very short account of some of the more recent developments of physics, and the new conceptions of physical processes to which they have led.

The period which has elapsed since the association last met in Canada has been one of almost unparalleled activity in many branches of physics, and many new and unsuspected properties of matter and electricity have been discovered. The history of this period affords a remarkable illustration of the effect which may be produced by a single discovery; for it is, I think, to the discovery of the Röntgen rays that we owe the rapidity of the progress which has recently been made in physics. A striking discovery like that of the Röntgen rays acts much like the discovery of gold in a sparsely populated country; it attracts workers who come in the first place for the gold, but who may find that the country has other products, other charms, perhaps even more valuable than the gold itself. The country in which the gold was discovered in the case of the Röntgen rays was the department of physics dealing with the discharge of electricity through gases, a subject which, almost from the beginning of electrical science, had attracted a few enthusiastic workers, who felt convinced that the key to unlock the secret of electricity was to be found in a vacuum tube. Röntgen, in 1895, showed that when electricity passed through such a tube, the tube emitted rays which could pass through bodies opaque to ordinary light; which could, for example, pass through the flesh of the body and throw a shadow of the bones on a suitable screen. The fascination of this discovery attracted many workers to the subject of the discharge of electricity through gases, and led to great improvements in the instruments used in this type of research. It is not, however, to the power of probing dark places, important though this is, that the influence of Röntgen rays on the progress of science has mainly been due; it is rather because these rays make gases, and, indeed, solids and liquids, through which they pass conductors of electricity. It is true that before the discovery of these rays other methods of making gases conductors were known, but none of these was so convenient for the purposes of accurate measurement.

The study of gases exposed to Röntgen rays has revealed in such gases the presence of particles charged with electricity; some of these particles are charged with positive, others with negative electricity.

The properties of these particles have been investigated; we know the charge they carry, the speed with which they move under an electric force, the rate at which the oppositely charged ones recombine, and these investigations have thrown a new light, not only on electricity, but also on the structure of matter.

We know from these investigations that electricity, like matter, is molecular in structure, that just as a quantity of hydrogen is a collection of an immense number of small particles called molecules, so a charge of electricity is made up of a great number of small charges, each of a perfectly definite and known amount.

Helmholtz said in 1880 that in his opinion the evidence in favor of the molecular constitution of electricity was even stronger than that in favor of the molecular consti-

tution of matter. How much stronger is that evidence now, when we have measured the charge on the unit and found it to be the same from whatever source the electricity is obtained. Nay, further, the molecular theory of matter is indebted to the molecular theory of electricity for the most accurate determination of its fundamental quantity, the number of molecules in any given quantity of an elementary substance.

The great advantage of the electrical methods for the study of the properties of matter is due to the fact that whenever a particle is electrified it is very easily identified, whereas an uncharged molecule is most elusive; and it is only when these are present in immense numbers that we are able to detect them. A very simple calculation will illustrate the difference in our power of detecting electrified and unelectrified molecules. The smallest quantity of unelectrified matter ever detected is probably that of neon, one of the inert gases of the atmosphere. Professor Strutt has shown that the amount of neon in one twentieth of a cubic centimeter of the air at ordinary pressures can be detected by the spectroscope; Sir William Ramsay estimates that the neon in the air only amounts to one part of neon in 100,000 parts of air, so that the neon in one twentieth of a cubic centimeter of air would only occupy at atmospheric pressure a volume of half a millionth of a cubic centimeter. When stated in this form the quantity seems exceedingly small, but in this small volume there are about ten million million molecules. Now the population of the earth is estimated at about fifteen hundred millions, so that the smallest number of molecules of neon we can identify is about 7,000 times the population of the earth. In other words, if we had no better test for the existence of a man than we have for that of an unelectrified molecule we should come to the conclusion that the earth is uninhabited. Contrast this with our power of detecting electrified molecules. We can by the electrical method, even better by the cloud method of C. T. R. Wilson, detect the presence of three or four charged particles in a cubic centimeter. Rutherford has shown that we can detect the presence of a single α particle. Now the particle is a charged atom of helium; if this atom had been uncharged we should have required more than a million million of them, instead of one, before we should have been able to detect them.

We may, I think, conclude, since electrified particles can be studied with so much greater ease than unelectrified ones, that we shall obtain a knowledge of the ultimate structure of electricity before we arrive at a corresponding degree of certainty with regard to the structure of matter.

We have already made considerable progress in the task of discovering what the structure of electricity is. We have known for some time that of one kind of electricity—the negative—and a very interesting one it is. We know that negative electricity is made up of units all of which are of the same kind; that these units are exceedingly small compared with even the smallest atom, for the mass of the unit is only $1/1700$ part of the mass of an atom of hydrogen; that its radius is only 10^{-13} centimeter, and that these units, "corpuscles" as they have been called, can be obtained from all substances. The size of these corpuscles is on an altogether different scale from that of atoms; the volume of a corpuscle bears to that of the atom about the same relation as that of a speck of dust to the volume of this room. Under suitable conditions they move at enormous speeds which approach in some instances the velocity of light.

The discovery of these corpuscles is an

interesting example of the way nature responds to the demands made upon her by mathematicians. Some years before the discovery of corpuscles it had been shown by a mathematical investigation that the mass of a body must be increased by a charge of electricity. This increase, however, is greater for small bodies than for large ones, and even bodies as small as atoms are hopelessly too large to show any appreciable effect; thus the result seemed entirely academic. After a time corpuscles were discovered, and these are so much smaller than the atom that the increase in mass due to the charge becomes not merely appreciable, but so great that, as the experiments of Kaufmann and Bucherer have shown, the whole of the mass of the corpuscle arises from its charge.

We know a great deal about negative electricity; what do we know about positive electricity? Is positive electricity molecular in structure? Is it made up into units, each unit carrying a charge equal in magnitude though opposite in sign to that carried by a corpuscle? Does, or does not, this unit differ, in size and physical properties, very widely from the corpuscle? We know that by suitable processes we can get corpuscles out of any kind of matter, and that the corpuscles will be the same from whatever source they may be derived. Is a similar thing true for positive electricity? Can we get, for example, a positive unit from oxygen of the same kind as that we get from hydrogen?

For my own part, I think the evidence is in favor of the view that we can, although the nature of the unit of positive electricity makes the proof much more difficult than for the negative unit.

In the first place we find that the positive particles—"canalstrahlen" is their technical name—discovered by our distinguished guest, Dr. Goldstein, which are found when an electric discharge passes through a highly rarefied gas, are, when the pressure is very low, the same, whatever may have been the gas in the vessel to begin with. If we pump out the gas until the pressure is too low to allow the discharge to pass, and then introduce a small quantity of gas and restart the discharge, the positive particles are the same whatever kind of gas may have been introduced.

I have, for example, put into the exhausted vessel oxygen, argon, helium, the vapor of carbon tetrachloride, none of which contain hydrogen, and found the positive particles to be the same as when hydrogen was introduced.

Some experiments made lately by Wellisch, in the Cavendish Laboratory, strongly support the view that there is a definite unit of positive electricity independent of the gas from which it is derived; these experiments were on the velocity with which positive particles move through mixed gases. If we have a mixture of methyl-iodide and hydrogen exposed to Röntgen rays, the effect of the rays on the methyl-iodide is so much greater than on the hydrogen that, even when the mixture contains only a small percentage of methyl-iodide, practically all the electricity comes from this gas, and not from the hydrogen.

Now if the positive particles were merely the residue left when a corpuscle had been abstracted from the methyl-iodide, these particles would have the dimensions of a molecule of methyl-iodide; this is very large and heavy, and would therefore move more slowly through the hydrogen molecules than the positive particles derived from hydrogen itself, which would, on this view, be of the size and weight of the light hydrogen molecules. Wellisch found that the velocities of both the positive and negative particles through the mixture were the same as the velocities through pure hydrogen, although in the one case the ions had originated from methyl-iodide and in the

other from hydrogen; a similar result was obtained when carbon tetrachloride, or mercury methyl, was used instead of methyl-iodide. These and similar results lead to the conclusion that the atoms of the different chemical elements contain definite units of positive as well as of negative electricity, and that the positive electricity, like the negative, is molecular in structure.

The investigations made on the unit of positive electricity show that it is of quite a different kind from the unit of negative, the mass of the negative unit is exceedingly small compared with any atom, the only positive units that up to the present have been detected are quite comparable in mass with the mass of an atom of hydrogen; in fact they seem equal to it. This makes it more difficult to be certain that the unit of positive electricity has been isolated, for we have to be on our guard against its being a much smaller body attached to the hydrogen atoms which happen to be present in the vessel. If the positive units have a much greater mass than the negative ones, they ought not to be so easily deflected by magnetic forces when moving at equal speeds; and in general the insensibility of the positive particles to the influence of a magnet is very marked; though there are cases when the positive particles are much more readily deflected, and these have been interpreted as proving the existence of positive units comparable in mass with the negative ones. I have found, however, that in these cases the positive particles are moving very slowly, and that the ease with which they are deflected is due to the smallness of the velocity and not to that of the mass. It should, however, be noted that M. Jean Becquerel has observed in the absorption spectra of some minerals, and Professor Wood in the rotation of the plane of polarization by sodium vapor, effects which could be explained by the presence in the substances of positive units comparable in mass with corpuscles. This, however, is not the only explanation which can be given of these effects, and at present the smallest positive electrified particles of which we have direct experimental evidence have masses comparable with that of an atom of hydrogen.

A knowledge of the mass and size of the two units of electricity, the positive and the negative, would give us the material for constructing what may be called a molecular theory of electricity, and would be a starting-point for a theory of the structure of matter; for the most natural view to take, as a provisional hypothesis, is that matter is just a collection of positive and negative units of electricity, and that the forces which hold atoms and molecules together, the properties which differentiate one kind of matter from another, all have their origin in the electrical forces exerted by positive and negative units of electricity, grouped together in different ways in the atoms of the different elements.

As it would seem that the units of positive and negative electricity are of very different sizes, we must regard matter as a mixture containing systems of very different types, one type corresponding to the small corpuscle, the other to the large positive unit.

Since the energy associated with a given charge is greater the smaller the body on which the change is concentrated, the energy stored up in the negative corpuscles will be far greater than that stored up by the positive. The amount of energy which is stored up in ordinary matter in the form of the electrostatic potential energy of its corpuscles is, I think, not generally realized. All substances give out corpuscles, so that we may assume that each atom of a substance contains at least one corpuscle. From the size and the charge on the corpuscle, both of which are known, we find that each cor-

puscle has 8×10^{-7} ergs of energy; this is on the supposition that the usual expressions for the energy of a charged body hold when, as in the case of a corpuscle, the charge is reduced to one unit. Now in one gram of hydrogen there are about 6×10^{23} atoms, so if there is only one corpuscle in each atom the energy due to the corpuscles in a gram of hydrogen would be 48×10^{16} ergs, or 11×10^{9} calories. This is more than seven times the heat developed by one gram of radium, or than that developed by the burning of five tons of coal. Thus we see that even ordinary matter contains enormous stores of energy; this energy is fortunately kept fast bound by the corpuscles; if at any time an appreciable fraction were to get free the earth would explode and become a gaseous nebula.

The matter of which I have been speaking so far is the material which builds up the earth, the sun, and the stars, the matter studied by the chemist, and which he can represent by a formula; this matter occupies, however, but an insignificant fraction of the universe, it forms but minute islands in the great ocean of the ether, the substance with which the whole universe is filled.

The ether is not a fantastic creation of the speculative philosopher; it is as essential to us as the air we breathe. For we must remember that we on this earth are not living on our own resources; we are dependent from minute to minute upon what we are getting from the sun, and the gifts of the sun are conveyed to us by the ether. It is to the sun that we owe not merely night and day, springtime and harvest, but it is the energy of the sun, stored up in coal, in waterfalls, in food, that practically does all the work of the world.

How great is the supply the sun lavishes upon us becomes clear when we consider that the heat received by the earth under a high sun and a clear sky is equivalent, according to the measurements of Langley, to about 7,000 horse-power per acre. Though our engineers have not yet discovered how to utilize this enormous supply of power, they will, I have not the slightest doubt, ultimately succeed in doing so; and when coal is exhausted and our water-power inadequate, it may be that this is the source from which we shall derive the energy necessary for the world's work. When that comes about, our centers of industrial activity may perhaps be transferred to the burning deserts of the Sahara, and the value of land determined by its suitability for the reception of traps to catch sunbeams.

This energy, in the interval between its departure from the sun and its arrival at the earth, must be in the space between them. Thus this space must contain something which, like ordinary matter, can store up energy, which can carry at an enormous pace the energy associated with light and heat, and which can, in addition, exert the enormous stresses necessary to keep the earth circling round the sun and the moon round the earth.

The study of this all-pervading substance is perhaps the most fascinating and important duty of the physicist.

On the electromagnetic theory of light, now universally accepted, the energy streaming to the earth travels through the ether in electric waves; thus practically the whole of the energy at our disposal has at one time or another been electrical energy. The ether must, then, be the seat of electrical and magnetic forces. We know, thanks to the genius of Clerk Maxwell, the founder and inspirer of modern electrical theory, the equations which express the relation between these forces, and although for some purposes these are all we require, yet they do not tell us very much about the nature of the ether.

The interest inspired by equations, too, in some minds is apt to be somewhat Platonic; and something more grossly mechanical—a model, for example, is felt by many to be more suggestive and manageable, and for them a more powerful instrument of research, than a purely analytical theory.

Is the ether dense or rare? Has it a structure? Is it at rest or in motion? are some of the questions which force themselves upon us.

Let us consider some of the facts known about the ether. When light falls on a body and is absorbed by it, the body is pushed forward in the direction in which the light is traveling, and if the body is free to move it is set in motion by the light. Now it is a fundamental principle of dynamics that when a body is set moving in a certain direction, or, to use the language of dynamics, acquires momentum in that direction, some other mass must lose the same amount of momentum; in other words, the amount of momentum in the universe is constant. Thus when the body is pushed forward by the light some other system must have lost the momentum the body acquires, and the only other system available is the wave of light falling on the body; hence we conclude that there must have been momentum in the wave in the direction in which it is traveling. Momentum, however, implies mass in motion. We conclude, then, that in the ether through which the wave is moving there is mass moving with the velocity of light. The experiments made on the pressure due to light enable us to calculate this mass, and we find that in a cubic kilometer of ether carrying light as intense as sunlight is at the surface of the earth, the mass moving is only about one fifty-millionth of a milligram. We must be careful not to confuse this with the mass of a cubic kilometer of ether; it is only the mass moved when the light passes through it; the vast majority of the ether is left undisturbed by the light. Now, on the electro-magnetic theory of light, a wave of light may be regarded as made up of groups of lines of electric force moving with the velocity of light; and if we take this point of view we can prove that the mass of ether per cubic centimeter carried along is proportional to the energy possessed by these lines of electric force per cubic centimeter, divided by the square of the velocity of light. But though lines of electric force carry some of the ether along with them as they move, the amount so carried, even in the strongest electric fields we can produce, is but a minute fraction of the ether in their neighborhood.

This is proved by an experiment made by Sir Oliver Lodge in which light was made to travel through an electric field in rapid motion. If the electric field had carried the whole of the ether with it, the velocity of the light would have been increased by the velocity of the electric field. As a matter of fact no increase whatever could be detected, though it would have been registered if it had amounted to one-thousandth part of that of the field.

The ether carried along by a wave of light must be an exceedingly small part of the volume through which the wave is spread. Parts of this volume are in motion, but by far the greater part is at rest; thus in the wave front there can not be uniformity, at some parts the ether is moving, at others it is at rest—in other words, the wave front must be more analogous to bright specks on a dark ground than to a uniformly illuminated surface.

The place where the density of the ether carried along by an electric field rises to its highest value is close to a corpuscle, for round the corpuscles are by far the strongest electric fields of which we have any knowledge. We know the mass of the corpuscle, we know from Kaufmann's experi-

ments that this arises entirely from the electric charge, and is therefore due to the ether carried along with the corpuscle by the lines of force attached to it.

A simple calculation shows that one half of this mass is contained in a volume seven times that of a corpuscle. Since we know the volume of the corpuscle as well as the mass, we can calculate the density of the ether attached to the corpuscle; doing so, we find it amounts to the prodigious value of about 5×10^{10}, or about 2,000 million times that of lead. Sir Oliver Lodge, by somewhat different considerations, has arrived at a value of the same order of magnitude.

Thus around the corpuscle ether must have an extravagant density: whether the density is as great as this in other places depends upon whether the ether is compressible or not. If it is compressible, then it may be condensed round the corpuscles, and there have an abnormally great density; if it is not compressible, then the density in free space can not be less than the number I have just mentioned.

With respect to this point we must remember that the forces acting on the ether close to the corpuscle are prodigious. If the ether were, for example, an ideal gas whose density increased in proportion to the pressure, however great the pressure might be, then if, when exposed to the pressures which exist in some directions close to the corpuscle, it had the density stated above, its density under atmospheric pressure would only be about 8×10^{-16}, or a cubic kilometer would have a mass less than a gram; so that instead of being almost incomparably denser than lead, it would be almost incomparably rarer than the lightest gas.

I do not know at present of any effect which would enable us to determine whether ether is compressible or not. And although at first sight the idea that we are immersed in a medium almost infinitely denser than lead might seem inconceivable, it is not so if we remember that in all probability matter is composed mainly of holes. We may, in fact, regard matter as possessing a bird-cage kind of structure in which the volume of the ether disturbed by the wires when the structure is moved is infinitesimal in comparison with the volume enclosed by them. If we do this, no difficulty arises from the great density of the ether; all we have to do is to increase the distance between the wires in proportion as we increase the density of the ether.

Let us now consider how much ether is carried along by ordinary matter, and what effects this might be expected to produce.

The simplest electrical system we know, an electrified sphere, has attached to it a mass of ether proportional to its potential energy, and such that if the mass were to move with the velocity of light its kinetic energy would equal the electrostatic potential energy of the particle. This result can be extended to any electrified system, and it can be shown that such a system binds a mass of the ether proportional to its potential energy. Thus a part of the mass of any system is proportional to the potential energy of the system.

The question now arises, Does this part of the mass add anything to the weight of the body? If the ether were not subject to gravitational attraction it certainly would not; and even if the ether were ponderable, we might expect that as the mass is swimming in a sea of ether it would not increase the weight of the body to which it is attached. But if it does not, then a body with a large amount of potential energy may have an appreciable amount of its mass in a form which does not increase its weight, and thus the weight of a given mass of it may be less than that of an equal mass of

some substance with a smaller amount of potential energy. Thus the weights of equal masses of these substances would be different. Now, experiments with pendulums, as Newton pointed out, enable us to determine with great accuracy the weights of equal masses of different substances. Newton himself made experiments of this kind, and found that the weights of equal masses were the same for all the materials he tried. Bessel, in 1830, made some experiments on this subject which are still the most accurate we possess, and he showed that the weights of equal masses of lead, silver, iron, brass did not differ by as much as one part in 60,000.

The substances tried by Newton and Bessel did not, however, include any of those substances which possess the marvellous power of radioactivity; the discovery of these came much later, and is one of the most striking achievements of modern physics.

These radioactive substances are constantly giving out large quantities of heat, presumably at the expense of their potential energy; thus when these substances reach their final non-radioactive state their potential energy must be less than when they were radioactive. Professor Rutherford's measurements show that the energy emitted by one gram of radium in the course of its degradation to non-radioactive forms is equal to the kinetic energy of a mass of one thirteenth of a milligram moving with the velocity of light.

This energy, according to the rule I have stated, corresponds to a mass of one thirteenth of a milligram of the ether, and thus a gram of radium in its radioactive state must have at least one thirteenth of a milligram more of ether attached to it than when it has been degraded into the non-radioactive forms. Thus if this ether does not increase the weight of the radium, the ratio of mass to weight for radium would be greater by about one part in 13,000 than for its non-radioactive products.

I attempted several years ago to find the ratio of mass to weight for radium by swinging a little pendulum, the bob of which was made of radium. I had only a small quantity of radium, and was not, therefore, able to attain any great accuracy. I found that the difference, if any, in the ratio of the mass to weight between radium and other substances was not more than one part in 2,000. Lately we have been using at the Cavendish Laboratory a pendulum whose bob was filled with uranium oxide. We have got good reasons for supposing that uranium is a parent of radium, so that the great potential energy and large ethereal mass possessed by the radium will be also in the uranium; the experiments are not yet completed. It is, perhaps, expecting almost too much to hope that the radioactive substances may add to the great services they have already done to science by furnishing the first case in which there is some differentiation in the action of gravity.

The mass of ether bound by any system is such that if it were to move with the velocity of light its kinetic energy would be equal to the potential energy of the system. This result suggests a new view of the nature of potential energy. Potential energy is usually regarded as essentially different from kinetic energy. Potential energy depends on the configuration of the system, and can be calculated from it when we have the requisite data; kinetic energy, on the other hand, depends upon the velocity of the system. According to the principle of the conservation of energy the one form can be converted into the other at a fixed rate of exchange, so that when one unit of one kind disappears a unit of the other simultaneously appears.

Now in many cases this rule is all that we require to calculate the behavior of the system, and the conception of potential energy is of the utmost value in making the knowledge derived from experiment and observation available for mathematical calculation. It must, however, I think, be admitted that from the purely philosophical point of view it is open to serious objection. It violates, for example, the principle of continuity. When a thing changes from a state A to a different state B, the principle of continuity requires that it must pass through a number of states intermediate between A and B, so that the transition is made gradually, and not abruptly. Now, when kinetic energy changes into potential, although there is no discontinuity in the quantity of the energy, there is in its quality, for we do not recognize any kind of energy intermediate between that due to the motion and that due to the position of the system, and some portions of energy are supposed to change *per saltum* from the kinetic to the potential form. In the case of the transition of kinetic energy into heat energy in a gas, the discontinuity has disappeared with a fuller knowledge of what the heat energy in a gas is due to. When we were ignorant of the nature of this energy, the transition from kinetic into thermal energy seemed discontinuous; but now we know that this energy is the kinetic energy of the molecules of which the gas is composed, so that there is no change in the type of energy when the kinetic energy of visible motion is transformed into the thermal energy of a gas—it is just the transference of kinetic energy from one body to another.

If we regard potential energy as the kinetic energy of portions of the ether attached to the system, then all energy is kinetic energy, due to the motion of matter or of portions of ether attached to the matter. I showed, many years ago, in my "Applications of Dynamics to Physics and Chemistry," that we could imitate the effects of the potential energy of a system by means of the kinetic energy of invisible systems connected in an appropriate manner with the main system, and that the potential energy of the visible universe may in reality be the kinetic energy of an invisible one connected up with it. We naturally suppose that this invisible universe is the luminiferous ether, that portions of the ether in rapid motion are connected with the visible systems, and that their kinetic energy is the potential energy of the systems.

We may thus regard the ether as a bank in which we may deposit energy and withdraw it at our convenience. The mass of the ether attached to the system will change as the potential energy changes, and thus the mass of a system whose potential energy is changing can not be constant; the fluctuations in mass under ordinary conditions are, however, so small that they can not be detected by any means at present at our disposal. Inasmuch as the various forms of potential energy are continually being changed into heat energy, which is the kinetic energy of the molecules of matter, there is a constant tendency for the mass of a system such as the earth or the sun to diminish, and thus as time goes on for the mass of ether gripped by the material universe to become smaller and smaller; the rate at which it would diminish would, however, get slower as time went on, and there is no reason to think that it would ever get below a very large value.

Radiation of light and heat from an incandescent body like the sun involves a constant loss of mass by the body. Each unit of energy radiated carries off its quota of mass, but as the mass ejected from the sun

per year is only one part in 20 billionths (1 in 2×10^{18}) of the mass of the sun, and as this diminution in mass is not necessarily accompanied by any decrease in its gravitational attraction, we can not expect to be able to get any evidence of this effect.

As our knowledge of the properties of light has progressed, we have been driven to recognize that the ether, when transmitting light, possesses properties which, before the introduction of the electro-magnetic theory, would have been thought to be peculiar to an emission theory of light and to be fatal to the theory that light consists of undulations.

Take, for example, the pressure exerted by light. This would follow as a matter of course if we supposed light to be small particles moving with great velocities, for these, if they struck against a body, would manifestly tend to push it forward, while on the undulatory theory there seemed no reason why any effect of this kind should take place.

Indeed, in 1792, this very point was regarded as a test between the theories, and Bennet made experiments to see whether or not he could find any traces of this pressure. We now know that the pressure is there, and if Bennet's instrument had been more sensitive he must have observed it. It is perhaps fortunate that Bennet had not at his command more delicate apparatus. Had he discovered the pressure of light, it would have shaken confidence in the undulatory theory and checked that magnificent work at the beginning of the last century which so greatly increased our knowledge of optics.

As another example, take the question of the distribution of energy in a wave of light. On the emission theory the energy in the light is the kinetic energy of the light particles. Thus the energy of light is made up of distinct units, the unit being the energy of one of the particles.

The idea that the energy has a structure of this kind has lately received a good deal of support. Planck, in a very remarkable series of investigations on the thermodynamics of radiation, pointed out that the expressions for the energy and entropy of radiant energy were of such a form as to suggest that the energy of radiation, like that of a gas on the molecular theory, was made up of distinct units, the magnitude of the unit depending on the color of the light; and on this assumption he was able to calculate the value of the unit, and from this deduce incidentally the value of Avogadro's constant—the number of molecules in a cubic centimeter of gas at standard temperature and pressure.

This result is most interesting and important because if it were a legitimate deduction from the second law of thermodynamics, it would appear that only a particular type of mechanism for the vibrators which give out light and the absorbers which absorb it could be in accordance with that law.

If this were so, then, regarding the universe as a collection of machines all obeying the laws of dynamics, the second law of thermodynamics would only be true for a particular kind of machine.

There seems, however, grave objection to this view, which I may illustrate by the case of the first law of thermodynamics, the principle of the conservation of energy. This must be true whatever be the nature of the machines which make up the universe, provided they obey the laws of dynamics, any application of the principle of the conservation of energy could not discriminate between one type of machine and another.

Now, the second law of thermodynamics, though not a dynamical principle in as

strict a sense as the law of the conservation of energy, is one that we should expect to hold for a collection of a large number of machines of any type, provided that we could not directly affect the individual machines, but could only observe the average effects produced by an enormous number of them. On this view, the second law, as well as the first, should be incapable of saying that the machines were of any particular type: so that investigations founded on thermodynamics, though the expressions they lead to may suggest—can not, I think, be regarded as proving—the unit structure of light energy.

It would seem as if in the application of thermodynamics to radiation some additional assumption has been implicitly introduced, for these applications lead to definite relations between the energy of the light of any particular wave-length and the temperature of the luminous body.

Now a possible way of accounting for the light emitted by hot bodies is to suppose that it arises from the collisions of corpuscles with the molecules of the hot body, but it is only for one particular law of force between the corpuscles and the molecules that the distribution of energy would be the same as that deduced by the second law of thermodynamics, so that in this case, as in the other, the results obtained by the application of thermodynamics to radiation would require us to suppose that the second law of thermodynamics is only true for radiation when the radiation is produced by mechanism of a special type.

Quite apart, however, from considerations of thermodynamics, we should expect that the light from a luminous source should in many cases consist of parcels, possessing, at any rate to begin with, a definite amount of energy. Consider, for example, the case of a gas like sodium vapor, emitting light of a definite wave-length; we may imagine that this light, consisting of electrical waves, is emitted by systems resembling Leyden jars. The energy originally possessed by such a system will be the electrostatic energy of the charged jar. When the vibrations are started, this energy will be radiated away into space, the radiation forming a complex system, containing, if the jar has no electrical resistance, the energy stored up in the jar.

The amount of this energy will depend on the size of the jar and the quantity of electricity with which it is charged. With regard to the charge, we must remember that we are dealing with systems formed out of single molecules, so that the charge will only consist of one or two natural units of electricity, or, at all events, some small multiple of that unit, while for geometrically similar Leyden jars the energy for a given charge will be proportional to the frequency of the vibration; thus, the energy in the bundle of radiation will be proportional to the frequency of the vibration.

We may picture to ourselves the radiation as consisting of the lines of electric force which, before the vibrations were started, were held bound by the charges on the jar, and which, when the vibrations begin, are thrown into rhythmic undulations, liberated from the jar and travel through space with the velocity of light.

Now let us suppose that this system strikes against an uncharged condenser and gives it a charge of electricity, the charge on the plates of the condenser must be at least one unit of electricity, because fractions of this charge do not exist, and each unit charge will anchor a unit tube of force, which must come from the parcel of radiation falling upon it. Thus a tube in the incident light will be anchored by the condenser, and the parcel formed by

this tube will be anchored and withdrawn as a whole from the pencil of light incident on the condenser. If the energy required to charge up the condenser with a unit of electricity is greater than the energy in the incident parcel, the tube will not be anchored and the light will pass over the condenser and escape from it. These principles that radiation is made up of units, and that it requires a unit possessing a definite amount of energy to excite radiation in a body on which it falls, perhaps receive their best illustration in the remarkable laws governing secondary Röntgen radiation, recently discovered by Professor Barkla. Professor Barkla has found that each of the different chemical elements, when exposed to Röntgen rays, emit a definite type of secondary radiation whatever may have been the type of primary, thus lead emits one type, copper another, and so on; but these radiations are not excited at all if the primary radiation is of a softer type than the specific radiation emitted by the substance; thus the secondary radiation from lead being harder than that from copper; if copper is exposed to the secondary radiation from lead the copper will radiate, but lead will not radiate when exposed to copper. Thus, if we suppose that the energy in a unit of hard Röntgen rays is greater than that in one of soft, Barkla's results are strikingly analogous to those which would follow on the unit theory of light.

Though we have, I think, strong reasons for thinking that the energy in the light waves of definite wave-length is done up into bundles, and that these bundles, when emitted, all possess the same amount of energy, I do not think there is any reason for supposing that in any casual specimen of light of this wave-length, which may subsequent to its emission have been many times refracted or reflected, the bundles possess any definite amount of energy. For consider what must happen when a bundle is incident on a suface such as glass, when part of it is reflected and part transmitted. The bundle is divided into two portions, in each of which the energy is less than the incident bundle, and since these portions diverge and may ultimately be many thousands of miles apart, it would seem meaningless to still regard them as forming one unit. Thus the energy in the bundles of light, after they have suffered partial reflection, will not be the same as in the bundles when they were emitted. The study of the dimensions of these bundles, for example, the angle they subtend at the luminous source, is an interesting subject for investigation; experiments on interference between rays of light emerging in different directions from the luminous source would probably throw light on this point.

I now pass to a very brief consideration of one of the most important and interesting advances ever made in physics, and in which Canada, as the place of the labors of Professors Rutherford and Soddy, has taken a conspicuous part. I mean the discovery and investigation of radioactivity. Radioactivity was brought to light by the Röntgen rays. One of the many remarkable properties of these rays is to excite phosphorescence in certain substances, including the salts of uranium, when they fall upon them. Since Röntgen rays produce phosphorescence, it occurred to Becquerel to try whether phosphorescence would produce Röntgen rays. He took some uranium salts which had been made to phosphoresce by exposure, not to Röntgen rays but to sunlight, tested them, and found that they gave out rays possessing properties similar to Röntgen rays. Further investigation showed, however, that to get these rays it was not necessary

to make the uranium phosphoresce, that the salts were just as active if they had been kept in the dark. It thus appeared that the property was due to the metal and not to the phosphorescence, and that uranium and its compounds possessed the power of giving out rays which, like Röntgen rays, affect a photographic plate, make certain minerals phosphoresce, and make gases through which they pass conductors of electricity.

Niepce de Saint-Victor had observed some years before this discovery that paper soaked in a solution of uranium nitrate affected a photographic plate, but the observation excited but little interest. The ground had not then been prepared, by the discovery of the Röntgen rays, for its reception, and it withered and was soon forgotten.

Shortly after Becquerel's discovery of uranium, Schmidt found that thorium possessed similar properties. Then Monsieur and Madame Curie, after a most difficult and laborious investigation, discovered two new substances, radium and polonium, possessing this property to an enormously greater extent than either thorium or uranium, and this was followed by the discovery of actinium by Debierne. Now the researches of Rutherford and others have led to the discovery of so many new radioactive substances that any attempt at christening seems to have been abandoned, and they are denoted, like policemen, by the letters of the alphabet.

Mr. Campbell has recently found that potassium, though far inferior in this respect to any of the substances I have named, emits an appreciable amount of radiation, the amount depending only on the quantity of potassium, and being the same whatever the source from which the potassium is obtained or whatever the elements with which it may be in combination.

The radiation emitted by these substances is of three types known as α, β and γ rays. The α rays have been shown by Rutherford to be positively electrified atoms of helium, moving with speeds which reach up to about one tenth of the velocity of light. The β rays are negatively electrified corpuscles, moving in some cases with very nearly the velocity of light itself, while the γ rays are unelectrified, and are analogous to the Röntgen rays.

The radioactivity of uranium was shown by Crookes to arise from something mixed with the uranium, and which differed sufficiently in properties from the uranium itself to enable it to be separated by chemical analysis. He took some uranium, and by chemical treatment separated it into two portions, one of which was radioactive and the other not.

Next Becquerel found that if these two portions were kept for several months, the part which was not radioactive to begin with regained radioactivity, while the part which was radioactive to begin with had lost its radioactivity. These effects and many others receive a complete explanation by the theory of radioactive change which we owe to Rutherford and Soddy.

According to this theory, the radioactive elements are not permanent, but are gradually breaking up into elements of lower atomic weight; uranium, for example, is slowly breaking up, one of the products being radium, while radium breaks up into a radioactive gas called radium emanation, the emanation into another radioactive substance, and so on, and that the radiations are a kind of swan's song emitted by the atoms when they pass from one form to another; that, for example, it is when a radium atom breaks up and an atom of the emanation appears that the rays which constitute the radioactivity are produced.

Thus, on this view the atoms of the radio-

active elements are not immortal, they perish after a life whose average value ranges from thousands of millions of years in the case of uranium to a second or so in the case of the gaseous emanation from actinium.

When the atoms pass from one state to another they give out large stores of energy, thus their descendants do not inherit the whole of their wealth of stored-up energy, the estate becomes less and less wealthy with each generation; we find, in fact, that the politician, when he imposes death duties, is but imitating a process which has been going on for ages in the case of these radioactive substances.

Many points of interest arise when we consider the rate at which the atoms of radioactive substances disappear. Rutherford has shown that whatever be the age of these atoms, the percentage of atoms which disappear in one second is always the same; another way of putting it is that the expectation of life of an atom is independent of its age—that an atom of radium one thousand years old is just as likely to live for another thousand years as one just sprung into existence.

Now this would be the case if the death of the atom were due to something from outside which struck old and young indiscriminately; in a battle, for example, the chance of being shot is the same for old and young; so that we are inclined at first to look to something coming from outside as the cause why an atom of radium, for example, suddenly changes into an atom of the emanation. But here we are met with the difficulty that no changes in the external conditions that we have as yet been able to produce have had any effect on the life of the atom; as far as we know at present the life of a radium atom is the same at the temperature of a furnace as at that of liquid air—it is not altered by surrounding the radium by thick screens of lead or other dense materials to ward off radiation from outside, and what to my mind is especially significant, it is the same when the radium is in the most concentrated form, when its atoms are exposed to the vigorous bombardment from the rays given off by the neighboring atoms, as when it is in the most dilute solution, when the rays are absorbed by the water which separates one atom from another. This last result seems to me to make it somewhat improbable that we shall be able to split up the atoms of the non-radioactive elements by exposing them to the radiation from radium; if this radiation is unable to affect the unstable radioactive atoms, it is somewhat unlikely that it will be able to affect the much more stable non-radioactive elements.

The evidence we have at present is against a disturbance coming from outside breaking up of the radioactive atoms, and we must therefore look to some process of decay in the atom itself; but if this is the case, how are we to reconcile it with the fact that the expectation of life of an atom does not diminish as the atom gets older? We can do this if we suppose that the atoms when they are first produced have not all the same strength of constitution, that some are more robust than others, perhaps because they contain more intrinsic energy to begin with, and will therefore have a longer life. Now if when the atoms are first produced there are some which will live for one year, some for ten, some for a thousand, and so on; and if lives of all durations, from nothing to infinity, are present in such proportion that the number of atoms which will live longer than a certain number of years decrease in a constant proportion for each additional year of life, we can easily prove that the expectation of life of an atom will be the same whatever its age may be. On this view the

different atoms of a radioactive substance are not, in all respects, identical.

The energy developed by radioactive substances is exceedingly large, one gram of radium developing nearly as much energy as would be produced by burning a ton of coal. This energy is mainly in the α particles, the positively charged helium atoms which are emitted when the change in the atom takes place; if this energy were produced by electrical forces it would indicate that the helium atom had moved through a potential difference of about two million volts on its way out of the atom of radium. The source of this energy is a problem of the deepest interest; if it arises from the repulsion of similarly electrified systems exerting forces varying inversely as the square of the distance, then to get the requisite amount of energy the systems, if their charges were comparable with the charge on the α particle, could not when they start be further apart than the radius of a corpuscle, 10^{-13} cm. If we suppose that the particles do not acquire this energy at the explosion, but that before they are shot out of the radium atom they move in circles inside this atom with the speed with which they emerge, the forces required to prevent particles moving with this velocity from flying off at a tangent are so great that finite charges of electricity could only produce them at distances comparable with the radius of a corpuscle.

One method by which the requisite amount of energy could be obtained is suggested by the view to which I have already alluded—that in the atom we have electrified systems of very different types, one small, the other large; the radius of one type is comparable with 10^{-13} cm., that of the other is about 100,000 times greater. The electrostatic potential energy in the smaller bodies is enormously greater than that in the larger ones; if one of these small bodies were to explode and expand to the size of the larger ones, we should have a liberation of energy large enough to endow an α particle with the energy it possesses. Is it possible that the positive units of electricity were, to begin with, quite as small as the negative, but while in the course of ages most of these have passed from the smaller stage to the larger, there are some small ones still lingering in radioactive substances, and it is the explosion of these which liberates the energy set free during radioactive transformation?

The properties of radium have consequences of enormous importance to the geologist as well as to the physicist or chemist. In fact, the discovery of these properties has entirely altered the aspect of one of the most interesting geological problems, that of the age of the earth. Before the discovery of radium it was supposed that the supplies of heat furnished by chemical changes going on in the earth were quite insignificant, and that there was nothing to replace the heat which flows from the hot interior of the earth to the colder crust. Now when the earth first solidified it only possessed a certain amount of capital in the form of heat, and if it is continually spending this capital and not gaining any fresh heat it is evident that the process can not have been going on for more than a certain number of years, otherwise the earth would be colder than it is. Lord Kelvin in this way estimated the age of the earth to be less than 100 million years. Though the quantity of radium in the earth is an exceedingly small fraction of the mass of the earth, only amounting, according to the determinations of Professors Strutt and Joly, to about five grams in a cube whose side is 100 miles, yet the amount of heat given out by this small quantity of radium is so great that it is more than enough to replace the heat which flows from the inside to the

outside of the earth. This, as Rutherford has pointed out, entirely vitiates the previous method of determining the age of the earth. The fact is that the radium gives out so much heat that we do not quite know what to do with it, for if there was as much radium throughout the interior of the earth as there is in its crust, the temperature of the earth would increase much more rapidly than it does as we descend below the earth's surface. Professor Strutt has shown that if radium behaves in the interior of the earth as it does at the surface, rocks similar to those in the earth's crust can not extend to a depth of more than forty-five miles below the surface.

It is remarkable that Professor Milne from the study of earthquake phenomena had previously come to the conclusion that rocks similar to those at the earth's surface only descend a short distance below the surface; he estimates this distance at about thirty miles, and concludes that at a depth greater than this the earth is fairly homogeneous. Though the discovery of radioactivity has taken away one method of calculating the age of the earth it has supplied another.

The gas helium is given out by radioactive bodies, and since, except in beryls, it is not found in minerals which do not contain radioactive elements, it is probable that all the helium in these minerals has come from these elements. In the case of a mineral containing uranium, the parent of radium in radioactive equilibrium, with radium and its products, helium will be produced at a definite rate. Helium, however, unlike the radioactive elements, is permanent and accumulates in the mineral; hence if we measure the amount of helium in a sample of rock and the amount produced by the sample in one year we can find the length of time the helium has been accumulating, and hence the age of the rock. This method, which is due to Professor Strutt, may lead to determinations not merely of the average age of the crust of the earth, but of the ages of particular rocks and the date at which the various strata were deposited; he has, for example, shown in this way that a specimen of the mineral thorianite must be more than 240 million years old.

The physiological and medical properties of the rays emitted by radium is a field of research in which enough has already been done to justify the hope that it may lead to considerable alleviation of human suffering. It seems quite definitely established that for some diseases, notably rodent ulcer, treatment with these rays has produced remarkable cures; it is imperative, lest we should be passing over a means of saving life and health, that the subject should be investigated in a much more systematic and extensive manner than there has yet been either time or material for. Radium is, however, so costly that few hospitals could afford to undertake pioneering work of this kind; fortunately, however, through the generosity of Sir Ernest Cassel and Lord Iveagh a Radium Institute, under the patronage of his Majesty the King, has been founded in London for the study of the medical properties of radium, and for the treatment of patients suffering from diseases for which radium is beneficial.

The new discoveries made in physics in the last few years, and the ideas and potentialities suggested by them, have had an effect upon the workers in that subject akin to that produced in literature by the Renaissance. Enthusiasm has been quickened, and there is a hopeful, youthful, perhaps exuberant, spirit abroad which leads men to make with confidence experiments which would have been thought fantastic twenty years ago. It has quite dispelled

the pessimistic feeling, not uncommon at that time, that all the interesting things had been discovered, and all that was left was to alter a decimal or two in some physical constant. There never was any justification for this feeling, there never were any signs of an approach to finality in science. The sum of knowledge is at present, at any rate, a diverging not a converging series. As we conquer peak after peak we see in front of us regions full of interest and beauty, but we do not see our goal, we do not see the horizon; in the distance tower still higher peaks, which will yield to those who ascend them still wider prospects, and deepen the feeling, whose truth is emphasized by every advance in science, that "Great are the Works of the Lord."

J. J. Thomson

ROBERT EDWARDS CARTER STEARNS

Dr. Robert Edwards Carter Stearns died at Los Angeles, Cal., July 27, in his eighty-third year. He was a native of Boston, Mass., a son of Charles Stearns, and was born February 1, 1827. He was educated in the public schools, followed by a course of mercantile training, and from his earliest years evinced a deep love of nature, fostered by his father, with whom similar tastes led to a degree of comradeship in rambles and hunting expeditions which he always remembered with appreciation. The boy had an unusual artistic ability, and, though his early avocations were services in a bank and on a farm, when only twenty-two years of age he painted a panorama of the Hudson River from the mouth of the Mohawk to Fort William, which he exhibited with much success. He turned his attention to mining, explored the coal fields of southern Indiana, and in 1854 was appointed resident agent of several copper mines in northern Michigan, on Lake Superior. In 1858 he went to California, where he became a partner in the large printing establishment of a brother-in-law of his wife, in San Francisco. This firm published the *Pacific Methodist*, a weekly religious paper, and in the troubled times preceding the civil war the reverend editor of this journal was obliged to visit the east. Stearns was requested to fill this place during his absence. The fate of California hung in the balance, many of the immigrants from the southern states urged independence for that territory when hostilities broke out. Stearns took the responsibility of making his paper an enthusiastic advocate of the union cause, and to this call and the eloquence of Thomas Starr King, old Californians believed the decision of the people to stand by the Union in that struggle was due in no small degree. Through the influence of Justice Field, Stearns was appointed deputy clerk of the supreme court of California in 1862, a post which he resigned in the following year to accept the secretaryship of the State Board of Harbor Commissioners, which he was obliged to resign some years later on account of ill health. Coming to the east, he made one of a party, comprising besides himself the late Dr. William Stimpson and Col. Ezekiel Jewett, for the exploration of the invertebrate fauna of southwestern Florida, during which large collections were made for the Smithsonian Institution. He returned to California, and in 1874 was elected secretary of the University of California, being the business executive of that institution under the presidency of the late Dr. Daniel C. Gilman. He served in this capacity for eight years with great approval, and, when ill health again obliged him to retire from service, the university as expressive of their sense of his services to the cause of education in California, and in recognition of his scientific attainments, conferred upon him the degree of doctor of philosophy. Returning to the east after the death of Mrs. Stearns, he was engaged in researches for the U. S. Fish Commission in 1882, was appointed paleontologist to the U. S. Geological Survey by Major Powell in 1884, and assistant curator of mollusks in the National Museum by Professor Baird. His collection of mollusca was acquired by the museum. Age and infirmity obliged him to return to the more genial climate

of California in 1892, where he settled in Los Angeles, continuing, as his strength permitted, his researches into the malacology of the Pacific coast. He married March 28, 1850, Mary Anne Libby, daughter of Oliver Libby, of Boston, and is survived by a daughter.

Dr. Stearns was an earnest student of mollusks from boyhood; his early experience led him to interest himself in horticulture and landscape gardening, and his ability in this line is attested by the beauty of the university grounds at Berkeley, which were developed under his superintendence. His knowledge of the Pacific coast mollusca was profound, and a long list of papers on this topic and on the shells of Florida was the result. He also contributed many papers on various branches of horticulture and gardening to the California periodicals devoted to this subject. He was an enthusiastic supporter of the California Academy of Sciences in its early days, and, after the earthquake of 1868, when disaster threatened the society, he, with Professor J. D. Whitney and a few other friends, stood between it and dissolution. He was a member of numerous scientific societies at home and abroad, and of the Sons of the Revolution.

Dr. Stearns was a man of sanguine temperament, with a lively sense of humor and high moral character. His reading was wide, his learning never obtrusive, his interest in art, literature and all good causes, intense. He was a staunch friend and, for a righteous object, ever ready to sacrifice his own material interests. His services to Californian science will keep his memory green.

Wm. H. Dall

SCIENTIFIC NOTES AND NEWS

At a meeting of the Paris Academy of Sciences on August 18, the permanent secretary gave a eulogy of Professor Simon Newcomb, who was a foreign associate of the academy.

In the last issue of Science it was noted that at the celebration of the five-hundredth anniversary of the University of Leipzig the degree of doctor of medicine was given to Professor E. B. Wilson, of Columbia University, and the degree of doctor of philosophy to Professor Jacques Loeb, of the University of California. The degree of doctor of philosophy was also given to Professor A. A. Michelson, of the University of Chicago. There were in all five degrees given to Americans, more than to the citizens of any foreign country except Austria. The two other degrees were to Mr. Roosevelt and Professor J. W. Burgess, of Columbia University.

Clark University will hold its second decennial celebration from September 6 to 11, the exercises being under the auspices of the department of psychology and the department of pedagogy and school hygiene. Those from abroad who will give lectures are Professors L. William Sterns, of Berlin; Dr. C. G. Jung, of Zurich; Dr. Leo Bergerstein, of Vienna, and Dr. Sigmund Freud, of Vienna. Among those from America who give lectures are Dr. Ellsworth Brown, Professor E. B. Titchener, Professor Franz Boas, Professor H. S. Jennings and Professor Adolf Meyer.

The Paris Academy of Sciences has decided to signalize its appreciation of work in aeronautics by devoting $4,000 to striking gold and enamel medals which will be presented to foreign and French aeronauts. Medals will be awarded to the Wright brothers, and to MM. Bleriot and Voisin.

It is stated in *Nature* that the Cracow Academy of Sciences has awarded the Nicolas Copernic prize, amounting to 1,000 crowns, to M. Jean Krassowski, of Cracow, for his treatment of the question, "A l'aide de la méthode de M. A. Schuster, examiner la question si les périodes des variations des latitudes, indiquées par MM. Chandler, Kimura, etc., sont réelles ou non." The Constantin Simon prize, of 900 crowns, for a work in the Polish language on mathematics or physics, has been adjudicated to M. Stanislas Zaremba, for his book "Exposé des premiers Principes de la Théorie des Nombres entiers."

The Paris correspondent of the *Journal* of the American Medical Association reports that the Academy of Sciences has awarded three prizes of $500 (2,500 francs) each, one to Dr. Neumann for his researches on the family of the ixodidæ and on the various groups of para-

sites of the superior vertebrates; one to Dr. Charles Nicolle for his works on infantile kala-azar, and one to Professor J. Bergonié and Dr. L. Tribondeau, of Bordeaux, for their work on Röntgen rays and fulguration. In the same competition three second prizes of $300 (1,500 francs) each were awarded, one to Professor H. Truc and Dr. P. Chavernac, of Montpellier for their work on ocular hygiene and ophthalmologic inspection of schools; one to MM. C. Porcher and C. Hervieux for their "Investigations on Indol and Some of its Derivatives"; and one to M. Moussu, professor at the National Veterinary School of Alfort, for his "Investigations on the Tuberculosis of Cattle." The Godard prize ($200) was awarded to Dr. Pousson, professor at the College of Medicine of Bordeaux, for his "Surgery of Nephritis." The Bellion prize ($280) was awarded to Dr. C. Nicolas, resident physician of Lifu, New Caledonia, for his work, "Public and Private Hygiene of the Kanakas of the Loyalty Islands." The Bréant prize ($20,000), offered for a cure for Asiatic cholera, was not awarded; but out of the accumulated interest of this fund the academy awarded a prize of $800 to W. M. Haffkine for his work on vaccination and bubonic plague, and a second prize of $200 to Dr. Louis Rénon, physician of the hospital of Paris, for his work entitled "Practical Treatment of Pulmonary Tuberculosis."

PROFESSOR ARMIN O. LEUSCHNER, director of the Students' Observatory of the University of California, has returned from abroad where he spent his sabbatical leave of absence.

M. DARBOUX, the eminent mathematician, permanent secretary of the Paris Academy of Sciences, has been appointed the official delegate to represent France at the approaching Hudson-Fulton celebration.

AT the recent celebration at Leipzig, President J. G. Schurman, of Cornell University, made the address on behalf of American universities.

UNIVERSITY AND EDUCATIONAL NEWS

THE council of the city of Cincinnati has appropriated the sum of $576,000 to erect three new buildings for the University of Cincinnati.

BY the will of Cornelius C. Cuyler, the New York banker and a trustee of Princeton University, $100,000 is bequeathed to Princeton University. The residue of the estate, which is said to be very large, will go to the university after the death of Mrs. Cuyler.

MR. THOMAS SHEVLIN has given $60,000 to the University of Minnesota. Of this sum $10,000 will be used to enlarge Alice Shevlin Hall and $50,000 to endow five scholarships.

GROUND has been broken for the new wing to the engineering building at the University of Wisconsin. It is to raise the present half-height third story of the west end of the building to a full story, with a half-height fourth story above for drafting rooms. Ultimately a similar wing will be built at the east end of the building. The ground dimensions of the wing are 40 × 70 feet, and the material is the same pressed brick as the main building, with Bedford stone trimming and slate roof.

THE new medical college of the University of Cincinnati—the Ohio-Miami Medical College—will open its first session in the old university building on the McMicken Homestead, which has been completely equipped for the purpose. Dr. P. G. Woolley, of the University of Nebraska, has been appointed professor of pathology, and Dr. William B. Wherry, of the Public Health and Marine-Hospital Service, assistant professor of bacteriology.

AT the University of Chicago associate professors have been appointed from among assistant professors as follows: Carl Kinsley, physics; Charles B. Child, zoology; Anton J. Carlson, physiology, and H. Gideon Wells, pathology.

DR. E. B. BRYAN, president of Franklin College, in Indiana, has been elected president of Colgate University, at Hamilton, N. Y.

DR. R. K. MCCLUNG, for the past two years in charge of the physics department of Mount Allison University, Sackville, N. B., and previously on the physics staff of McGill University, has accepted an appointment to the lectureship of physics in the University of Manitoba, Winnipeg.

SCIENTIFIC BOOKS

Artificial and Natural Flight. By Sir HIRAM MAXIM. New York, The Macmillan Co. $1.75 net.

Sir Hiram Maxim, the celebrated inventor and manufacturer of the machine gun which bears his name, has published in a book of 165 pages an account of the experiments which he made for and with a flying machine from 1889 to 1894, and he has supplemented this with his own observations and reflections, so as to form a valuable guide to others who may contemplate like work.

The preface and the introductory chapter bestow some hard slaps upon mathematicians who have written upon aviation; for Mr. Maxim believes that practical experiment alone is to be relied upon, and he states that all the successful flying machines of to-day are built upon the lines which he had thought out and found to be the best.

In the chapters upon Air Currents and upon Kites he describes some very interesting observations upon the rising trends of winds with which soaring birds probably perform their astonishing feats. He expresses the belief, however, that "we shall never be able to imitate the flight of the soaring birds. We can not hope to make a sensitive apparatus which will work quick enough to take advantage of the rising currents of air." It is possible that Mr. Maxim is mistaken.

Then he gives an account of his experiments upon screws, on the coefficient of air resistance of various forms, on the best shapes for aeroplanes and for condensers and then passes to hints as to the building of flying machines, which it is greatly to be hoped he will apply himself, now that the success of others has removed the odium which attached to such experiments less than fifteen years ago.

Mr. Maxim discusses briefly the Santos-Dumont, the Farman, the De la Grange and the Blériot flying machines, while he expresses doubts in the main body of the book as to the truth of the "alleged flights" of the Wright Brothers, which he takes back in the appendix. His calculations of resistances and horse power required are somewhat vague; he figures for the De la Grange machine that at an angle of incidence of 1 in 10 the screw thrust would be 100 pounds, requiring 10.66 H.P. to overcome the drift, and he allows another 10 H.P. for the atmospheric resistance due to the motor, the man and the framework of the machine, reaching the conclusion that of the 50 H.P. developed, 29 H.P. will be consumed in slip. This is probably erroneous. If the cross sectional area of the air-resisting parts be measured and proper coefficient applied it will be found that they require a good deal more than 10 H.P. to overcome the resistance at 40 miles an hour, and that the slip of the screw is much less than estimated.

Mr. Maxim has no good opinion of balloons. He devotes a chapter to them, but expresses the opinion that the day of the balloon is past, evidently not recognizing the fact that the flying machine, while capable of great speed, is limited in size and carrying capacity by its own increase of weight as the cube of its linear dimensions, eventually reaching a size beyond which it is no longer practicable, while the balloon increases in surplus lifting power faster than its own weight and promises some usefulness in spite of its inferior speed, its bulk and its fragility.

Mr. Maxim gives an account, all too brief, of his own flying machine, weighing some 8,000 pounds, with 4,000 to 6,000 square feet of sustaining surfaces, a motor of 363 H.P., this being a steam engine of his own design of unprecedented lightness, developing a thrust at the screws of 2,164 pounds. This wonderful and immense apparatus, the work of a very able engineer, was run very many times over a railway track of nine feet gauge, being restrained from rising more than two feet by guard rails of timber of thirty feet gauge. With this arrangement many tests were made and data obtained preliminary to an attempt at free flight, but on July 31, 1894, the apparatus rose with such force as to burst through the guard rails and enter upon a cruise. Steam was shut off at once and the machine, after flying perhaps 200 feet, fell and was broken. It was repaired, but various circumstances have prevented its being tested again.

There were two causes for this failure. First, the stability was deficient, as subsequently recognized, and second, Mr. Maxim did not and could not know how to handle it in the air, for lack of preliminary practise in free flight. The gradual training which all successful aviators have had to go through during the last five years is an abundant demonstration, and one of the marvels of the evolution is that so few fatal accidents have occurred to the experimenters, although there have been almost innumerable breakages of the machines.

O. Chanute

Our Insect Friends and Enemies. By John B. Smith, ScD., Professor of Entomology in Rutgers College and Entomologist of the New Jersey Agricultural Experiment Station. Philadelphia, J. B. Lippincott Company. 1909. Pp. 314, 1 plate. $1.50.

The many good insect books which have appeared during the past few years have not entirely filled the need for more literature of the right sort. A careful reading of this book shows it to be quite different in scope from any of its predecessors. The object is not to present a scheme of classification, a manual of insect anatomy, or a handbook of injurious species of insects, yet these phases are treated incidentally and satisfactorily.

In the foreword the author explains that his object has been to present an account of the relation of insects to other living things. In this he has been eminently successful, and it would be difficult indeed in a book of its size to give a more comprehensive and complete general survey of the whole subject. To the student and working entomologist this book is useful, but especially to the lay reader who sometimes gets an exaggerated idea of the value of parasites or remedial measures in destroying noxious species, is this volume of great value because it shows these relations in their true light and perspective.

The average individual has little knowledge about the recent discoveries relating to the transmission of human and other animal diseases by insects, especially flies, mosquitoes and fleas. In fact, his only source of information has been the newspapers, which print occasional disjointed statements regarding this very important matter. Chapter IX. makes this subject plain to anyone who will read it—and everybody ought to read it.

Chapters IV. and V., on the relation of insects to each other and their relation to animals, are particularly good and deserve to have a wide reading.

A critical person might question the statement regarding the formation of galls on page 78: "and the remarkable point is, that the gall is purely a production of the plant, and the insect has apparently nothing at all to do with it." That the irritation, stimulus or injury of the insect which causes a gall of definite and characteristic shape to form on a particular plant is little known, is true, yet it can not be considered that the insect has "apparently nothing at all to do with it," when the attack of each different species of Cynipidæ or Cecidomyidæ causes a different but entirely characteristic gall to form on the same host plant. However, this is partly explained below on the same page by Professor Smith.

A good colored plate of household insects forms the frontispiece to the volume, which is well printed on good paper, and attractively bound in tan-colored linen.

Of the 121 figures in the text about 35 are new, and were made from excellent pen drawings.

The book is remarkably free from typographical or other errors, the only one noticed being the mis-spelled specific name of the Angoumois grain moth *Gelechia cerealella* Oliv., on page 242.

This volume should find a place in every library of entomological works, and every public library should have a copy.

W. E. Britton

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NOTES ON ENTOMOLOGY

Mr. G. H. Verrall has completed another volume in the series of books on the Diptera of Great Britain.[1] This volume includes all

[1] "British Flies," Vol. V., London, 1909, 780 pp., 406 figs.

of the Brachycera except the Empidæ, Dolichopodidæ, Lonchopteridæ and Phoridæ. He gives the characters of all the subfamilies and important European genera, whether occurring in England or not. His arrangement of the brachycerous Diptera is based on that of Osten Sacken, but with several important modifications. It is as follows: Eremochæta (Stratomyidæ, Leptidæ, Tabanidæ, Nemestrinidæ and Cyrtidæ); Tromoptera (Bombylidæ and Therevidæ); Dermatina (Scenopinidæ and Mydaidæ) Ernegopoda (Apioceridæ and Asilidæ); Microphona (Empidæ and Dolichopodidæ); Acroptera (Lonchopteridæ), and Hypocera (Phoridæ). He puts *Xylomyia* in the Stratiomyidæ and *Xylophagus* in the Leptidæ. In the Asilinæ he uses the various genera proposed, but, recognizing the difficulty of their identification, he also gives a table of the British species based on superficial characters. An important feature is an illustrated article on the larvæ of the Brachycera, and of the Syrphidæ, Platypezidæ and Pipunculidæ by David Sharp, partly translated from Brauer. In the back is a list of the species common to Europe and North America, and as a supplement a catalogue of the Palæarctic Diptera Brachycera (except Dolichopodidæ and Empidæ).

DR. L. G. NEUMANN has issued a useful little book on the parasites and diseases of domestic birds.[2] It contains much interesting matter on the insects and mites that attack poultry and pigeons, arranged according to the parts affected. There is a short description of each parasite, the nature and appearance of the injury it causes, and the remedies that may be used to combat it. Most of the figures of these forms are original and accurate.

DRS. J. W. W. STEPHENS and S. R. Christophers have prepared a book[3] that will be of much help and interest to the many who are now concerned in the study of medical entomology. The entomological part is in two chapters on ticks, one on tsetse flies, etc., and fifteen chapters on mosquitoes. In the latter are directions for collecting, rearing, dissection, etc. There are chapters on How to Prepare a Blood Film, How to Detect the Malaria Parasite, How to Make a Malarial Survey, on the Life-history of the Malarial Parasite, on Piroplasma and on Trypanosoma and the diseases produced by them.

DR. J. KENNEL has begun the issuance of a large work on the European Tortricid moths.[4] Part I. is published, and contains an account of the structure, habits, life-history and variability of the leaf-rollers, and a table for the determination of the 55 genera. There is a long account of the relationships of the genera, and the phylogeny of the groups, illustrated by a plate of wing venation. The systematic part treats of the 43 species of *Acalla,* while the beautiful plates figure the species of this genus and those of *Philedone, Epagoge* and *Cacœcia.* There are to be 24 plates in the entire work, which is partially supported by a grant from the Elizabeth Thompson Science Fund.

MR. E. P. VAN DUZEE has published the results of a recent collecting trip to Florida.[5] Over 330 species were taken, 28 of which are described as new. He finds that the hemipterous fauna of Florida is made up of four elements: (1) the Carolinian, which spread southward from the Georgia mountains; (2) the West Indian, which has extended over the tip of Florida and up each coast; (3) a few forms from Texas and Mexico; and (4) the endemic species, which are very numerous, and largely local adaptations of the Carolinian migrants.

PROFESSOR C. T. VORHIES has issued a useful paper dealing with the immature stages of some Wisconsin caddice-flies.[6] The larvæ of

[2] "Parasites et Maladies parasitaires des Oiseaux domestiques," Paris, 1909, 230 pp., 89 figs.

[3] "The Practical Study of Malaria, and Other Blood Parasites," London, 1908, 414 pp., 128 figs.

[4] "Die Palæarktischen Tortriciden, Zoologica," Hft. 54, 1908, 4to, 6 pls., 100 pp.

[5] "Observations on Some Hemiptera taken in Florida in the Spring of 1908," *Bull. Buffalo Soc. Nat. Hist.*, IX., pp. 149–230, 1909.

[6] "Studies on the Trichoptera of Wisconsin," *Trans. Wisc. Acad. Science*, XVI., pp. 647–718, 10 pls., 1909.

these aquatic insects are but little known in this country, and Professor Vorhies has made a good start in describing 18 species that he reared to adult. Six species are considered new. The figures show the structural characters of the larvæ and also of some of the adults.

THE larvæ of gnats of the genus *Chironomus* have often been studied by naturalists, but not the least interesting is a posthumous paper by A. T. Mundy.[7] The part on the anatomy of the head seems to be particularly well done. There are detailed accounts of the making of the larval tubes, and a summary of the habits of allied *Chironomus* larvæ.

THE largest volume so far published on the "Collections Zoologiques du Baron Edm. de Selys Longchamps" is Fascicle VIII., a monograph of the Ascalaphidæ[8] by H. van der Weele. The de Selys collection is particularly rich in this family, possessing many types of Latreille and Rambur. About 200 species are now known, arranged in 50 genera, and the author has had peculiar facilities in studying specimens in many museums and collections. To the two former subfamilies, Schizophthalminæ and Holophthalminæ, he adds a new subfamily, Protascalaphinæ, for *Stilbopteryx* and *Albardia*.

IN this same series René Martin has published two fascicles (XIX., XX.) on the dragon-flies of the group Æschnines, completing the account of this family. There are about 185 species in 28 genera, mostly belonging to *Æschna* or *Gynacantha*. Many species are described as new, especially from Mr. Martin's collection.

NATHAN BANKS

SPECIAL ARTICLES

AN EXPERIMENT IN MUSICAL ESTHETICS

IN the field of psychology, few subjects offer as many difficulties to the investigator as that of esthetics, and in the realm of esthetics, few topics are more obscure than those that relate to the art of music.

Problems in musical esthetics, by their very nature, can not be adequately understood without taking account of both their psychological and their purely musical aspects. Unfortunately for the solution of such problems, however, the psychologist and the musician, in too many instances, not only fail to cooperate in their studies, but even lack an appreciative and sympathetic understanding of each other's methods and conclusions. We are much in need of two-handed men, equipped in both directions—or else, of intimate collaboration between the investigators in the separate fields.

Largely because of a lack of just such collaboration, the subject of musical dissonance has been invested with an atmosphere of uncertainty and confusion, in the minds of both psychologists, estheticians and musicians. The difficulties inhere, particularly, in ambiguous definitions of the word *dissonance* itself—definitions to which we have become so accustomed that, as a rule, we fail to notice their inadequacy. Among various uncertain and shifting meanings assigned to the term, two fairly defined conceptions present themselves: (1) a dissonance is a combination of simultaneous tones that *sounds harsh;* (2) a dissonance is a combination of simultaneous tones that *requires resolution* (*i. e.,* creates a feeling of unrest, removable only when the given combination of tones is followed by a more or less prescribed other combination). Either of these definitions is feasible and adequate, in itself; the confusion arises from the fact that, even among men usually careful of their terminology, the word *dissonance* is employed, first in the one sense and then in the other.

It seems to the present writer that the term *dissonance* will be both more nearly exact in its meaning, and more useful to the musician, if it be defined, simply, as a combination of simultaneous tones that *sounds harsh* (psychologically, the sensation produced by such a combination). Under the terms of this definition, the only dissonant intervals are those known as *seconds* and *sevenths;* and the only

[7] "The Anatomy, Habits and Psychology of *Chironomus pusio* Meigen (the Early Stages)," Leicester, England, 1909, pp. 56, 8 plates.

[8] "Ascalaphiden," Monographisch Bearbeitet, 326 pp., 254 figs., 2 col. plates, Brussels, 1909.

dissonant chords, those in which such intervals occur. This definition, it may be added, has been in use in the writer's classes for several years, with satisfactory results.

Objection to this position was recently made, on the ground that, in our experience, there is not so clear a discrimination, as is implied, between *seconds* and *sevenths*, on the one hand, and all the remaining intervals, on the other. Specifically, the claim was advanced that the interval of an *augmented fourth*, traditionally known as a dissonance, sounds equally harsh with the *seconds* and the *sevenths*.

In order to test the truth of these opposite opinions, the writer recently decided to conduct an experiment in which the reactions to various intervals might be determined in the case of persons who, though untrained in musical theory, are yet sensitive to musical effects. A collegiate class was selected for the experiment, a class of music-lovers ignorant of the technique of musical structure.

In order that the validity of the tests might not be affected by any preconceived notions on the part of the performer, the playing of the various intervals employed was entrusted to an assistant, who was kept in total ignorance of the nature and purpose of the experiment. The intervals were played on a grand pianoforte of good quality, and the assistant was instructed, as far as possible, to employ the same touch and intensity throughout the tests. Each interval was played from a manuscript copy; and, after a pause of perhaps two seconds, repeated. Before the following interval was performed, ten seconds, approximately, were allowed to elapse, during which the number of the coming test was announced; it was hoped that, in this way, the various combinations would be isolated. The order of presentation had been previously determined, by lot. Every care was exercised to make the experiment scientifically accurate; so that the results, it is believed, are, in every way, trustworthy.

The following explanation was written on the blackboard before the class: "Assume that all musical intervals (an interval is a combination of two simultaneous tones differing, more or less, in pitch) can be classified in two groups, which we shall call Group X and Group Y. Let Group X include intervals whose sound is *smooth;* let Group Y include intervals whose sound is *harsh*. Three intervals will now be played representing Group X; and afterward three intervals representing Group Y." At this point the assistant was called from an adjoining room, and requested to play the following intervals representing Group X: a *major third*, a *major sixth* and a *minor third*. Afterward, he was requested to play the following intervals representing Group Y: a *major seventh*, a *major second* and a *minor second*.

The actual tests were then presented to the class. These consisted of a series of twenty-two intervals, in which each combination from a *minor second* to a *major seventh* was included twice. The students were requested to record, in writing, the name of the group (X or Y) to which, in their judgment, each interval belonged.

Thirty-five students replied, affording seventy tests in the case of each interval. The results are collated in the following table:

	Smooth	Harsh
Minor second	0	70
Major second	5	65
Minor third	67	3
Major third	68	2
Perfect fourth	56	14
Augmented fourth	68	2
Perfect fifth	53	17
Minor sixth	68	2
Major sixth	69	1
Minor seventh	4	66
Major seventh	2	68

The significant features of the replies are:

1. The almost unanimous verdict that *seconds* and *sevenths* are harsh, whereas all other intervals are smooth.

2. The large number of dissenters from the prevailing opinion that *perfect fourths* and *perfect fifths* are smooth.

3. The almost unanimous verdict that the *augmented fourth* (the same, on the pianoforte, as the *diminished fifth*) is smooth—just as smooth as the *thirds* and *sixths*, and much

more smooth than the *perfect fourth* or the *perfect fifth.*

It is believed that these results are of significance, in connection with a number of problems in the field of musical esthetics.

The experiment described above has stimulated similar tests in other institutions. In Wellesley College, under the direction of Professor H. C. Macdougall, experiments were made by Miss Hetty S. Wheeler, in classes yielding 204 replies. Owing to a typographical error, 306 replies were received in the case of the *major sixth,* and only 102 in the case of the *perfect fifth.* The results from Wellesley College, which are very similar to those described above, are contained in the following table:

	Smooth	Harsh
Minor second	0	204
Major second	14	190
Minor third	199	5
Major third	204	0
Perfect fourth	139	65
Augmented fourth	166	38
Perfect fifth	72	30
Minor sixth	202	2
Major sixth	289	17
Minor seventh	14	190
Major seventh	0	204

Professor W. A. White, of Syracuse University, also, made a similar experiment, with somewhat different results. Inasmuch, however, as his tests were made on classes of students more or less advanced in the study of harmony, many of whom recognized the intervals as they were played, the experiment is obviously not comparable with those previously mentioned.

LEONARD B. MCWHOOD
COLUMBIA UNIVERSITY

THE FORTIETH GENERAL MEETING OF THE AMERICAN CHEMICAL SOCIETY. II

SECTION OF PHARMACEUTICAL CHEMISTRY

A. B. Stevens, chairman

A New Form of Separator: C. E. PARKER.

The "shaking out" method of extraction is difficult or impracticable with solutions which have marked tendency to emulsify. A separator of flat form is described, in which, when in a horizontal position, the immiscible liquids spread out in broad thin layers in contact with each other. By gently tilting the separator by manual or mechanical means the layers float about without mixing and the extraction of soluble material is readily effected. The operation may be called "floating out" instead of "shaking out." On placing the separator in erect position the lower liquid may be drawn off through a stopcock as usual.

Investigations of Glacial Phosphoric Acid: L. F. KEBLER and B. HERSTEIN.

It has been known for many years that the composition of glacial phosphoric acid is far from uniform, and its use so far as a chemical reagent and for the manufacture of medicinal products is of questionable utility. Furthermore, solutions of glacial phosphoric acid are comparatively unstable, the metaphosphoric acid reverting to the pyro and the pyro gradually to the ortho. The object of this contribution is: (1) to give a method for determining the respective amounts of the various hydrates of phosphorus pentoxid present in ordinary glacial phosphoric acid; (2) to determine the rapidity of reversion to the higher forms of hydration; (3) to show the undesirability of using it either as a reagent or for preparing medicines.

The Purity of Glycerin: H. C. FULLER and L. F. KEBLER.

In this paper is discussed results of investigations of the various brands of glycerin furnished by manufacturers knowing the object and purpose of such samples. The chief objects of the examinations were: (1) To determine whether or not the tests prescribed by the Pharmacopœia were unduly rigid. (2) Whether or not any glycerin was available which when used in making up Haines's solution would not be instrumental in causing a reduction of the copper.

Note on the Determination of Morphin: C. E. PARKER.

The use of a solution of thymol in chloroform (or other volatile solvent) for extracting morphin from solutions, especially those containing glycerol and small amounts of morphin, is described. Opium preparations are first freed from alcohol and then extracted with chloroform, first in acid or neutral solution and again after addition of excess of potassium hydroxid. The solution is then acidified, excess of sodium bicarbonate added and extracted with the thymol solution. The thymol solution is shaken out with one per cent. hydrochloric acid and the latter evaporated. The

morphin in the residue is determined as silicotungstate according to the method of Bertrand.

Notes on Two Important Alkaloidal Reactions: H. C. Fuller.

This paper discusses the value of the Vitali reaction and the bichromate sulphuric acid reaction in connection with the identification of small amounts of alkaloids in the forensic analysis of medicinal products.

Experiments were conducted with the residues left by extracting the alkaline solutions of various drugs with petroleum, ether and chloroform. It was shown that alkaloids extracted from belladonna, coca, colchicum, nux vomica and yohimbo gave the Vitali reaction with nitric acid and alcoholic potash. The purple color with bichromate and sulphuric acid was given to a greater or less extent by alkaloids extracted from gelsemium, hydrastis, nux vomica, opium, sanguinaria and yohimbe.

Directions are given for the separation and identification of the alkaloids in a mixture of coca, belladonna and nux vomica, and for distinguishing between strychnin and yohimbin when in small quantities. The difference in reactions between strychnin and the alkaloids of hydrastis, gelsemium, sanguinaria and opium is noted, and emphasis laid on the similarity of the reactions of a mixture of nux vomica and gelsemium to a mixture of belladonna and nux vomica.

The Estimation of Molybdenum Trioxid: B. Herstein.

Various methods for the purpose of determining the degree of purity of chemical reagents containing molybdenum have been given, but these varying methods are not only cumbersome, but unsatisfactory, as to final results. This paper contains a method for precipitating molybdenum from a strongly acid solution by means of thioacetic acid, and converting the purified precipitate by means of ignition to molybdic trioxid in a Gooch crucible. Other sulphur-bearing agents were also employed to precipitate the molybdenum with unsatisfactory results.

Tincture of Iodine: Azor Thurston.

An outline of methods for determining iodine, ethyl and hydrogen iodides, potassium iodide and alcohol.

Chemical Manipulations and the Variation of Results: W. A. Pearson.

The results of a chemical analysis are dependent upon three principal factors: (1) method employed, (2) technic of chemist, (3) accidental errors. The variation of results due to making reports for a moisture-free sample and a sample as received is discussed, and a recommendation made that results, in some way, should indicate the active principles in the drug as received.

The variation of results obtained in the standardization of deci-normal sulphuric acid is mentioned and the comparative accuracy of two methods shown.

The comparative accuracy of short methods and the widely separated views the public has of the chemist's ability, are mentioned.

The Need of Methods of Analysis of Pharmacopœial Articles: B. L. Murray.

In many instances the U. S. Pharmacopœia requires a high degree of purity without giving any quantitative methods of determining the purity. It is suggested that the American Chemical Society, through its Section of Pharmaceutical Chemistry, endeavor to find suitable methods of analysis, where they are now wanting in the Pharmacopœia.

Chemical and Physiological Assay of Aconite: A. B. Stevens.

Numerous experiments prove that aconite contains, in addition to aconitine, a non-active basic constituent which is much less soluble in ether than in chloroform. Consequently the latter should not be used in the assay of aconite or its preparations. The best method for the assay of aconite is believed to be the present pharmacopœial method, or better, the writer's original method in which the alcoholic extract was evaporated with powdered pumice stone.

Aconite root, under various conditions of age and preservation, were assayed by the method above and compared with the physiological method. The same methods were applied to galenical preparations in their normal condition, as well as to those which had been subjected to experiments with a view to partially decomposing the alkaloid. The results prove that the chemical method can be relied upon to determine the quality of aconite and its official preparations. Individuals are not alike sensitive to the action of aconite, hence the physiological method can not be relied upon for standardization.

The following papers were reported by title:

The Assay of Medicated Plasters: F. B. Kilmer.

Pharmacopœial Ash Standards: Edward Kremers.

Note on the Curing of Burdock Root: Edward Kremers.

B. E. Curry,
Press Secretary

(To be continued)

SCIENCE

FRIDAY, SEPTEMBER 3, 1909

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE[1]

ADDRESS OF THE PRESIDENT OF THE MATHEMATICAL AND PHYSICAL SECTION

IT is a great privilege and pleasure to address the members of this section on the occasion of the visit of the British Association to a country with which I have had such a long and pleasant connection. I feel myself in the presence of old friends, for the greater part of what may be called my scientific life has been spent in Canada, and I owe much to this country for the unusual facilities and opportunity for research so liberally provided by one of her great universities. Canada may well regard with pride her universities, which have made such liberal provision for teaching and research in pure and applied science. As a physicist, I may be allowed to refer in particular to the subject with which I am most intimately connected. After seeing the splendid home for physical science recently erected by the University of Toronto, and the older but no less serviceable and admirably equipped laboratories of McGill University, one can not but feel that Canada has recognized in a striking manner the great value attaching to teaching and research in physical science. In this, as in other branches of knowledge, Canada has made notable contributions in the past, and we may confidently anticipate that this is but an earnest of what will be accomplished in the future.

It is my intention to-day to say a few words upon the present position of the atomic theory in physical science, and to

[1] Winnipeg, 1909.

discuss briefly the various methods that have been devised to determine the values of certain fundamental atomic magnitudes. The present time seems very opportune for this purpose, for the rapid advance of physics during the last decade has not only given us a much clearer conception of the relation between electricity and matter and of the constitution of the atom, but has provided us with experimental methods of attack undreamt of a few years ago. At a time when, in the vision of the physicist, the atmosphere is dim with flying fragments of atoms, it may not be out of place to see how it has fared with the atoms themselves, and to look carefully at the atomic foundations on which the great superstructure of modern science has been raised. Every physicist and chemist can not but be aware of the great part the atomic hypothesis plays in science to-day. The idea that matter consists of a great number of small discrete particles forms practically the basis of the explanation of all properties of matter. As an indication of the importance of this theory in the advance of science it is of interest to read over the reports of this association and to note how many addresses, either wholly or in part, have been devoted to a consideration of this subject. Amongst numerous examples I may instance the famous and oft-quoted lecture of Maxwell on "Molecules," at Bradford in 1873; the discussion of the "Kinetic Theory of Gases" by Lord Kelvin, then Sir William Thomson, in Montreal in 1884; and the presidential address of Sir Arthur Rucker in 1901, which will be recalled by many here to-day.

It is far from my intention to discuss, except with extreme brevity, the gradual rise and development of the atomic theory. From the point of view of modern science, the atomic theory dates from the work of Dalton about 1805, who put it forward as an explanation of the combination of elements in definite proportions. The simplicity of this explanation of the facts of chemistry led to the rapid adoption of the atomic theory as a very convenient and valuable working hypothesis. By the labor of the chemists matter was shown to be composed of a number of elementary substances which could not be further decomposed by laboratory agencies, and the relative weights of the atoms of the elements were determined. On the physical side, the mathematical development of the kinetic or dynamical theory of gases by the labors of Clausius and Clerk Maxwell enormously extended the utility of this conception. It was shown that the properties of gases could be satisfactorily explained on the assumption that a gas consisted of a great assemblage of minute particles or molecules in continuous agitation, colliding with each other and with the walls of the containing vessel. Between encounters the molecules traveled in straight lines, and the free path of the molecules between collisions was supposed to be large compared with the linear dimensions of the molecules themselves. One can not but regard with admiration the remarkable success of this statistical theory in explaining the general properties of gases and even predicting unexpected relations. The strength and at the same time the limitations of the theory lie in the fact that it does not involve any definite conception of the nature of the molecules themselves or of the forces acting between them. The molecule, for example, may be considered as a perfectly elastic sphere or a Boscovitch center of force, as Lord Kelvin preferred to regard it, and yet on suitable assumptions the gas would show the same general statistical properties. We are consequently unable, without the aid of special subsidiary hypotheses, to draw conclusions of value in regard to the nature of the molecules themselves.

Towards the close of the last century the

ideas of the atomic theory had impregnated a very large part of the domain of physics and chemistry. The conception of atoms became more and more concrete. The atom in imagination was endowed with size and shape, and unconsciously in many cases with color. The simplicity and utility of atomic conceptions in explaining the most diverse phenomena of physics and chemistry naturally tended to enhance the importance of the theory in the eyes of the scientific worker. There was a tendency to regard the atomic theory as one of the established facts of nature, and not as a useful working hypothesis for which it was exceedingly difficult to obtain direct and convincing evidence. There were not wanting scientific men and philosophers to point out the uncertain foundations of the theory on which so much depended. Granting how useful molecular ideas were for the explanation of experimental facts, what evidence was there that the atoms were realities and not the figments of the imagination? It must be confessed that this lack of direct evidence did not in any way detract from the strength of the belief of the great majority of scientific men in the discreteness of matter. It was not unnatural, however, that there should be a reaction in some quarters against the domination of the atomic theory in physics and in chemistry. A school of thought arose that wished to do away with the atomic theory as the basis of explanation of chemistry, and substitute as its equivalent the law of combination in definite proportions. This movement was assisted by the possibility of explaining many chemical facts on the basis of thermodynamics without the aid of any hypothesis as to the particular structure of matter. Every one recognizes the great importance of such general methods of explanation, but the trouble is that few can think, or at any rate think correctly, in terms of thermodynamics. The negation of the atomic theory has not, and does not, help us to make new discoveries. The great advantage of the atomic theory is that it provides, so to speak, a tangible and concrete idea of matter which serves at once for the explanation of a multitude of facts and is of enormous aid as a working hypothesis. For the great majority of scientists it is not sufficient to group together a number of facts on general abstract principles. What is wanted is a concrete idea, however crude it may be, of the mechanism of the phenomena. This may be a weakness of the scientific mind, but it is one that deserves our sympathetic consideration. It represents an attitude of mind that appeals, I think, very strongly to the Anglo-Saxon temperament. It has no doubt as its basis the underlying idea that the facts of nature are ultimately explicable on general dynamical principles, and that there must consequently be some type of mechanism capable of accounting for the observed facts.

It has been generally considered that a decisive proof of the atomic structure of matter was in the nature of things impossible, and that the atomic theory must of necessity remain a hypothesis unverifiable by direct methods. Recent investigations have, however, disclosed such new and powerful methods of attack that we may well ask the question whether we do not now possess more decisive evidence of its truth.

Since molecules are invisible, it might appear, for example, an impossible hope that an experiment could be devised to show that the molecules of a fluid are in that state of continuous agitation which the kinetic theory leads us to suppose. In this connection I should like to draw your attention for a short time to a most striking phenomenon known as the "Brownian movement," which has been closely studied in recent years. Quite apart from its

probable explanation the phenomenon is of unusual interest. In 1827 the English botanist Brown observed by means of a microscope that minute particles like spores of plants introduced into a fluid were always in a state of continuous irregular agitation, dancing to and fro in all directions at considerable speeds. For a long time this effect, known as the Brownian movement, was ascribed to inequalities in the temperature of the solution. This was disproved by a number of subsequent investigations, and especially by those of Gouy, who showed that the movement was spontaneous and continuous and was exhibited by very small particles of whatever kind when immersed in a fluid medium. The velocity of agitation increased with decrease of diameter of the particles and increased with temperature, and was dependent on the viscosity of the surrounding fluid. With the advent of the ultra-microscope it has been possible to follow the movements with more certainty and to experiment with much smaller particles. Exner and Zsigmondy have determined the mean velocity of particles of known diameter in various solutions, while Svedberg has devised an ingenious method of determining the mean free path and the average velocity of particles of different diameter. The experiments of Ehrenhaft in 1907 showed that the Brownian movement was not confined to liquids, but was exhibited far more markedly by small particles suspended in gases. By passing an arc discharge between silver poles he produced a fine dust of silver in the air. When examined by means of the ultra-microscope the suspended particles exhibited the characteristic Brownian movement, with the difference that the mean free path for particles of the same size was much greater in gases than in liquids.

The particles exhibit in general the character of the motion which the kinetic theory ascribes to the molecules themselves, although even the smallest particles examined have a mass which is undoubtedly very large compared with that of the molecule. The character of the Brownian movement irresistibly impresses the observer with the idea that the particles are hurled hither and thither by the action of forces resident in the solution, and that these can only arise from the continuous and ceaseless movement of the invisible molecules of which the fluid is composed. Smoluchowski and Einstein have suggested explanations which are based on the kinetic theory, and there is a fair agreement between calculation and experiment. Strong additional confirmation of this view has been supplied by the very recent experiments of Perrin (1909). He obtained an emulsion of gamboge in water which consisted of a great number of spherical particles nearly of the same size, which showed the characteristic Brownian movement. The particles settled under gravity and when equilibrium was set up the distribution of these particles in layers at different heights was determined by counting the particles with a microscope. The number was found to diminish from the bottom of the vessel upwards according to an exponential law, *i. e.*, according to the same law as the pressure of the atmosphere diminishes from the surface of the earth. In this case, however, on account of the great mass of the particles, their distribution was confined to a region only a fraction of a millimeter deep. In a particular experiment the number of particles per unit volume decreased to half in a distance of 0.038 millimeter, while the corresponding distance in our atmosphere is about 6,000 meters. From measurements of the diameter and weight of each particle, Perrin found that, within the limit of experimental error, the law of distribution with height indicated that each small particle

had the same average kinetic energy of movement as the molecules of the solutions in which they were suspended; in fact, the particles in suspension behaved in all respects like molecules of very high molecular weight. This is a very important result, for it indicates that the law of equipartition of energy among molecules of different masses, which is an important deduction from the kinetic theory, holds, at any rate very approximately, for a distribution of particles in a medium whose masses and dimensions are exceedingly large compared with that of the molecules of the medium. Whatever may prove to be the exact explanation of this phenomenon, there can be little doubt that it results from the movement of the molecules of the solution and is thus a striking if somewhat indirect proof of the general correctness of the kinetic theory of matter.

From recent work in radioactivity we may take a second illustration which is novel and far more direct. It is well known that the α rays of radium are deflected by both magnetic and electric fields. It may be concluded from this evidence that the radiation is corpuscular in character, consisting of a stream of positively charged particles projected from the radium at a very high velocity. From the measurements of the deflection of the rays in passing through magnetic and electric fields the ratio e/m of the charge carried by the particle to its mass has been determined, and the magnitude of this quantity indicates that the particle is of atomic dimensions.

Rutherford and Geiger have recently developed a direct method of showing that this radiation is, as the other evidence indicated, discontinuous, and that it is possible to detect by a special electric method the passage of a single α particle into a suitable detecting vessel. The entrance of an α particle through a small opening was marked by a sudden movement of the needle of the electrometer which was used as a measuring instrument. In this way, by counting the number of separate impulses communicated to the electrometer needle, it was possible to determine by direct counting the number of α particles expelled per second from one gram of radium. But we can go further and confirm the result by counting the number of α particles by an entirely distinct method. Sir William Crookes has shown that when the α rays are allowed to fall upon a screen of phosphorescent zinc sulphide, a number of brilliant scintillations are observed. It appears as if the impact of each α particle produced a visible flash of light where it struck the screen. Using suitable screens the number of scintillations per second on a given area can be counted by means of a microscope. It has been shown that the number of scintillations determined in this way is equal to the number of impinging α particles when counted by the electric method. This shows that the impact of each α particle on the zinc sulphide produces a visible scintillation. There are thus two distinct methods—one electrical, the other optical—for detecting the emission of a single α particle from radium. The next question to consider is the nature of the α particle itself. The general evidence indicates that the α particle is a charged atom of helium, and this conclusion was decisively verified by Rutherford and Royds by showing that helium appeared in an exhausted space into which the α particles were fired. The helium, which is produced by radium, is due to the accumulated α particles which are so continuously expelled from it. If the rate of production of helium from radium is measured, we thus have a means of determining directly how many α particles are required to form a given volume of helium gas. This rate of production has recently been

measured accurately by Sir James Dewar. He has informed me that his final measurements show that one gram of radium in radioactive equilibrium produces 0.46 cubic millimeters of helium per day, or 5.32×10^{-6} cubic millimeters per second. Now from the direct counting experiments it is known that 13.6×10^{10} α particles are shot out per second from one gram of radium in equilibrium. Consequently it requires 2.56×10^{19} α particles to form one cubic centimeter of helium gas at standard pressure and temperature.

From other lines of evidence it is known that all the α particles from whatever source are identical in mass and constitution. It is not then unreasonable to suppose that the α particle, which exists as a separate entity in its flight, can exist also as a separate entity when the α particles are collected together to form a measurable volume of helium gas, or, in other words, that the α particle on losing its charge becomes the fundamental unit or atom of helium. In the case of a monatomic gas like helium, where the atom and molecule are believed to be identical, no difficulty of deduction arises from the possible combination of two or more atoms to form a complex molecule.

We consequently conclude from these experiments that one cubic centimeter of helium at standard pressure and temperature contains 2.56×10^{19} atoms. Knowing the density of helium, it at once follows that each atom of helium has a mass of 6.8×10^{-24} grams, and that the average distance apart of the molecules in the gaseous state at standard pressure and temperature is 3.4×10^{-7} centimeters.

The above result can be confirmed in a different way. It is known that the value of e/m for the α particle is 5,070 electromagnetic units. The positive charge carried by each α particle has been deduced by measuring the total charge carried by a counted number of α particles. Its value is 9.3×10^{-10} electrostatic units, or 3.1×10^{-20} electromagnetic units. Substituting this number in the value of e/m, it is seen that m, the mass of the α particle, is equal to 6.1×10^{-24} grams—a value in fair agreement with the number previously given.

I trust that my judgment is not prejudiced by the fact that I have taken some share in these investigations; but the experiments, taken as a whole, appear to me to give an almost direct and convincing proof of the atomic hypothesis of matter. By direct counting, the number of identical entities required to form a known volume of gas has been measured. May we not conclude that the gas is discrete in structure, and that this number represents the actual number of atoms in the gas?

We have seen that under special conditions it is possible to detect easily by an electrical method the emission of a single α particle—*i. e.*, of a single charged atom of matter. This has been rendered possible by the great velocity and energy of the expelled α particle, which confers on it the power of dissociating or ionizing the gas through which it passes. It is obviously only possible to detect the presence of a single atom of matter when it is endowed with some special property or properties which distinguishes it from the molecules of the gas with which it is surrounded. There is a very important and striking method, for example, of visibly differentiating between the ordinary molecules of a gas and the ions produced in the gas by various agencies. C. T. R. Wilson showed in 1897 that under certain conditions each charged ion became a center of condensation of water vapor, so that the presence of each ion was rendered visible to the eye. Sir Joseph Thomson, H. A. Wilson and others have employed this method to count the number of ions present

and to determine the magnitude of the electric charge carried by each.

A few examples will now be given which illustrate the older methods of estimating the mass and dimensions of molecules. As soon as the idea of the discrete structure of matter had taken firm hold, it was natural that attempts should be made to estimate the degree of coarse-grainedness of matter, and to form an idea of the dimension of molecules, assuming that they have extension in space. Lord Rayleigh has drawn attention to the fact that the earliest estimate of this kind was made by Thomas Young in 1805, from considerations of the theory of capillarity. Space does not allow me to consider the great variety of methods that have later been employed to form an idea of the thickness of a film of matter in which a molecular structure is discernible. This phase of the subject was always a favorite one with Lord Kelvin, who developed a number of important methods of estimating the probable dimensions of molecular structure.

The development of the kinetic theory of gases on a mathematical basis at once suggested methods of estimating the number of molecules in a cubic centimeter of any gas at normal pressure and temperature. This number, which will throughout be denoted by the symbol N, is a fundamental constant of gases; for, according to the hypothesis of Avogadro, and also on the kinetic theory, all gases at normal pressure and temperature have an identical number of molecules in unit volume. Knowing the value of N, approximate estimates can be made of the diameter of the molecule; but in our ignorance of the constitution of the molecule, the meaning of the term diameter is somewhat indefinite. It is usually considered to refer to the diameter of the sphere of action of the forces surrounding the molecule. This diameter is not necessarily the same for the molecules of all gases, so that it is preferable to consider the magnitude of the fundamental constant N. The earliest estimates based on the kinetic theory were made by Loschmidt, Johnstone Stoney and Maxwell. From the data then at his disposal, the latter found N to be 1.9×10^{19}. Meyer, in his "Kinetic Theory of Gases," discusses the various methods of estimating the dimensions of molecules on the theory, and concludes that the most probable estimate of N is 6.1×10^{19}. Estimates of N based on the kinetic theory are only approximate, and in many cases serve merely to fix an inferior or superior limit to the number of the molecules. Such estimates are, however, of considerable interest and historical importance, since for a long time they served as the most reliable methods of forming an idea of molecular magnitudes.

A very interesting and impressive method of determining the value of N was given by Lord Rayleigh in 1899 as a deduction from his theory of the blue color in the cloudless sky. This theory supposes that the molecules of the air scatter the waves of light incident upon them. This scattering for particles, small compared with the wave-length of light, is proportional to the fourth power of the wave-length, so that the proportion of scattered to incident light is much greater for the violet than for the red end of the spectrum, and consequently the sky which is viewed by the scattered light is of a deep blue color. This scattering of the light in passing through the atmosphere causes alterations of brightness of stars when viewed at different altitudes, and determinations of this loss of brightness have been made experimentally. Knowing this value, the number N of molecules in unit volume can be deduced by aid of the theory. From the data thus available, Lord Rayleigh concluded that the value of N was not less than 7×10^{18}. Lord Kelvin in 1902 recalculated the value

of N on the theory by using more recent and more accurate data, and found it to be 2.47×10^{19}. Since in the simple theory no account is taken of the additional scattering due to fine suspended particles which are undoubtedly present in the atmosphere, this method only serves to fix an inferior limit to the value of N. It is difficult to estimate with accuracy the correction to be applied for this effect, but it will be seen that the uncorrected number deduced by Lord Kelvin is not much smaller than the most probable value 2.77×10^{19} given later. Assuming the correctness of the theory and data employed, this would indicate that the scattering due to suspended particles in the atmosphere is only a small portion of the total scattering due to molecules of air. This is an interesting example of how an accurate knowledge of the value of N may possibly assist in forming an estimate of unknown magnitudes.

It is now necessary to consider some of the more recent and direct methods of estimating N which are based on recent additions to our scientific knowledge. The newer methods allow us to fix the value of N with much more certainty and precision than was possible a few years ago.

We have referred earlier in the paper to the investigations of Perrin on the law of distribution in a fluid of a great number of minute granules, and his proof that the granules behave like molecules of high molecular weight. The value of N can be deduced at once from the experimental results, and is found to be 3.14×10^{19}. The method developed by Perrin is a very novel and ingenious one, and is of great importance in throwing light on the law of equipartition of energy. This new method of attack of fundamental problems will no doubt be much further developed in the future.

It has already been shown that the value $N = 2.56 \times 10^{19}$ has been obtained by the direct method of counting the α particles and determining the corresponding volume of helium produced. Another very simple method of determining N from radioactive data is based on the rate of transformation of radium. Boltwood has shown by direct experiment that radium is half transformed in 2,000 years. From this it follows that initially in a gram of radium .346 milligram breaks up per year. Now it is known from the counting method that 3.4×10^{10} α particles are expelled per second from one gram of radium, and the evidence indicates that one α particle accompanies the disintegration of each atom. Consequently the number of α particles expelled per year is a measure of the number of atoms of radium present in .346 milligram. From this it follows that there are 3.1×10^{21} atoms in one gram of radium, and taking the atomic weight of radium as 226, it is simply deduced that the value of N is 3.1×10^{19}.

The study of the properties of ionized gases in recent years has led to the development of a number of important methods of determining the charge carried by the ion, produced in gases by α rays or the rays from radioactive substances. On modern views, electricity, like matter, is supposed to be discrete in structure, and the charge carried by the hydrogen atom set free by the electrolysis of water is taken as the fundamental unit of quantity of electricity. On this view, which is supported by strong evidence, the charge carried by the hydrogen atom is the smallest unit of electricity that can be obtained, and every quantity of electricity consists of an integral multiple of this unit. The experiments of Townsend have shown that the charge carried by a gaseous ion is, in the majority of cases, the same and equal in magnitude to the charge carried by a hydrogen atom in the electrolysis of water. From measurement of the quantity of electricity required to

set free one gram of hydrogen in electrolysis, it can be deduced that $Ne = 1.29 \times 10^{10}$ electrostatic units where N, as before, is the number of molecules of hydrogen in one cubic centimeter of gas, and e the charge carried by each ion. If e be determined experimentally, the value of N can at once be deduced from this relation.

The first direct measurement of the charge carried by the ion was made by Townsend in 1897. When a solution of sulphuric acid is electrolyzed, the liberated oxygen is found in a moist atmosphere to give rise to a dense cloud composed of minute globules of water. Each of these minute drops carries a negative charge of electricity. The size of the globules, and consequently the weight, was deduced with the aid of Stokes's formula by observing the rate of fall of the cloud under gravity. The weight of the cloud was measured, and, knowing the weight of each globule, the total number of drops present was determined. Since the total charge carried by the cloud was measured, the charge e carried by each drop was deduced. The value of e, the charge carried by each drop, was found by this method to be about 3.0×10^{-10} electrostatic units. The corresponding value of N is about 4.3×10^{19}.

We have already referred to the method discovered by C. T. R. Wilson of rendering each ion visible by the condensation of water upon it by a sudden expansion of the gas. The property was utilized by Sir Joseph Thomson to measure the charge e carried by each ion. When the expansion of the gas exceeds a certain value, the water condenses on both the negative and positive ions, and a dense cloud of small water drops is seen. J. J. Thomson found $e = 3.4 \times 10^{-10}$, H. A. Wilson $e = 3.1 \times 10^{-10}$, and Millikan and Begeman 4.06×10^{-10}. The corresponding values of N are 3.8, 4.2 and 3.2×10^{19} respectively. This method is of great interest and importance, as it provides a method of directly counting the number of ions produced in the gas. An exact determination of e by this method is, however, unfortunately beset with great experimental difficulties.

Moreau has recently measured the charge carried by the negative ions produced in flames. The values deduced for e and N were respectively 4.3×10^{-10} and 3.0×10^{19}.

We have referred earlier in the paper to the work of Ehrenhaft on the Brownian movement in air shown by ultra-microscopic dust of silver. In a recent paper (1909) he has shown that each of these particles carries a positive or negative charge. The size of each particle was measured by the ultra-microscope, and also by the rate of fall under gravity. The charge carried by each particle was deduced from the measured mass of the particle, and its rate of movement in an electric field. The mean value of e was found to be 4.6×10^{-10}, and thus N becomes 2.74×10^{19}.

A third important method of determination of N from radioactive data was given by Rutherford and Geiger in 1908. The charge carried by each α particle expelled from radium was measured by directly determining the total charge carried by a counted number of α particles. The value of the charge on each α particle was found to be 9.3×10^{-10}. From consideration of the general evidence, it was concluded that each α particle carries two unit positive charges, so that the value of e becomes 4.65×10^{-10}, and of N 2.77×10^{19}. This method is deserving of considerable confidence as the measurements involved are direct and capable of accuracy.

The methods of determination of e, so far explained, have depended on direct experiment. This discussion would not be complete without a reference to an important determination of e from theoretical considerations by Planck. From the

theory of the distribution of energy in the spectrum of a hot body, Planck found that $e = 4.69 \times 10^{-10}$, and $N = 2.80 \times 10^{19}$. For reasons that we can not enter into here, this theoretical deduction must be given great weight.

When we consider the great diversity of the theories and methods which have been utilized to determine the values of the atomic constants e and N, and the probable experimental errors, the agreement among the numbers is remarkably close. This is especially the case in considering the more recent measurements by very different methods, which are far more reliable than the older estimates. It is difficult to fix on one determination as more deserving of confidence than another; but I may be pardoned if I place some reliance on the radioactive method previously discussed, which depends on the charge carried by the α particle. The value obtained in this way is not only in close agreement with the theoretical estimate of Planck, but is in fair agreement with the recent determinations by several other distinct methods. We may consequently conclude that the number of molecules in a cubic centimeter of any gas at standard pressure and temperature is about 2.77×10^{19}, and that the value of the fundamental unit of quantity of electricity is about 4.65×10^{-10} electrostatic units. From these data it is a simple matter to deduce the mass of any atom whose atomic weight is known, and to determine the values of a number of related atomic and molecular magnitudes.

There is now no reason to view the values of these fundamental constants with scepticism, but they may be employed with confidence in calculations to advance still further our knowledge of the constitution of atoms and molecules. There will no doubt be a great number of investigations in the future to fix the values of these important constants with the greatest possible precision; but there is every reason to believe that the values are already known with reasonable certainty, and with a degree of accuracy far greater than it was possible to attain a few years ago. The remarkable agreement in the values of e and N, based on so many different theories, of itself affords exceedingly strong evidence of the correctness of the atomic theory of matter, and of electricity, for it is difficult to believe that such concordance would show itself if the atoms and their charges had no real existence.

There has been a tendency in some quarters to suppose that the development of physics in recent years has cast doubt on the validity of the atomic theory of matter. This view is quite erroneous, for it will be clear from the evidence already discussed that the recent discoveries have not only greatly strengthened the evidence in support of the theory, but have given an almost direct and convincing proof of its correctness. The chemical atom as a definite unit in the subdivision of matter is now fixed in an impregnable position in science. Leaving out of account considerations of etymology, the atom in chemistry has long been considered to refer only to the smallest unit of matter that enters into ordinary chemical combination. There is no assumption made that the atom itself is indestructible and eternal, or that methods may not ultimately be found for its subdivision into still more elementary units. The advent of the electron has shown that the atom is not the unit of smallest mass of which we have cognizance, while the study of radioactive bodies has shown that the atoms of a few elements of high atomic weight are not permanently stable, but break up spontaneously with the appearance of new types of matter. These advances in knowledge do not in any way invalidate the position of the chemical atom, but rather indicate its great impor-

tance as a subdivision of matter whose properties should be exhaustively studied.

The proof of the existence of corpuscles or electrons with an apparent mass very small compared with that of the hydrogen atom, marks an important stage in the extension of our ideas of atomic constitution. This discovery, which has exercised a profound influence on the development of modern physics, we owe mainly to the genius of the president of this association. The existence of the electron as a distinct entity is established by similar methods and with almost the same certainty as the existence of individual α particles. While it has not yet been found possible to detect a single electron by its electrical or optical effect, and thus to count the number directly as in the case of the α particles, there seems to be no reason why this should not be accomplished by the electric method. The effect to be anticipated for a single β particle is much smaller than that due to an α particle, but not too small for measurement. In this connection it is of interest to note that Regener has observed evidence of scintillations produced by the β particles of radium falling on a screen of platinocyanide of barium, but the scintillations are too feeble to count with certainty.

Experiment has shown that the apparent mass of the electron varies with its speed, and, by comparison of theory with experiment, it has been concluded that the mass of the electron is entirely electrical in origin and that there is no necessity to assume a material nucleus on which the electrical charge is distributed. While there can be no doubt that electrons can be released from the atom or molecule by a variety of agencies and, when in raipd motion, can retain an independent existence, there is still much room for discussion as to the actual constitution of electrons, if such a term may be employed, and of the part they play in atomic structure. There can be little doubt that the atom is a complex system, consisting of a number of positively and negatively charged masses which are held in equilibrium mainly by electrical forces; but it is difficult to assign the relative importance of the rôle played by the carriers of positive and negative electricity. While negative electricity can exist as a separate entity in the electron, there is yet no decisive proof of the existence of a corresponding positive electron. It is not known how much of the mass of an atom is due to electrons or other moving charges, or whether a type of mass quite distinct from electrical mass exists. Advance in this direction must be delayed until a clearer knowledge is gained of the character and structure of positive electricity and of its relation to the negative electron.

The general experimental evidence indicates that electrons play two distinct rôles in the structure of the atom, one as lightly attached and easily removable satellites or outliers of the atomic system, and the other as integral constituents of the interior structure of the atom. The former, which can be easily detached or set in vibration, probably play an important part in the combination of atoms to form molecules, and in the spectra of the elements; the latter, which are held in place by much stronger forces, can only be released as a result of an atomic explosion involving the disintegration of the atom. For example, the release of an electron with slow velocity by ordinary laboratory agencies does not appear to endanger the stability of the atom, but the expulsion of a high speed electron from a radioactive substance accompanies the transformation of the atom.

The idea that the atoms of the elements may be complex structures, made up either of lighter atoms or of the atoms of some fundamental substance, has long been fa-

miliar to science. So far no direct evidence has been obtained of the possibility of building up an atom of higher atomic weight from one of lower atomic weight, but in the case of the radioactive substances we have decisive and definite evidence that certain elements show the converse process of disintegration. It may be significant that this process has only been observed in the atoms of highest atomic weights, like those of uranium, thorium and radium. With the exception possibly of potassium, there is no reliable evidence that a similar process takes place in other elements. The transformation of the atom of a radioactive substance appears to result from an atomic explosion of great intensity in which a part of the atom is expelled with great speed. In the majority of cases, an α particle or atom of helium is ejected, in some cases a high-speed electron, while a few substances are transformed without the appearance of a detectable radiation. The fact that the α particles from a simple substance are all ejected with an identical and very high velocity suggests the probability that the charged helium atom before its expulsion is in rapid orbital movement in the atom. There is at present no definite evidence of the causes operative in these atomic transformations.

Since in a large number of cases the transformations of the atoms are accompanied by the expulsion of one or more charged atoms of helium, it is difficult to avoid the conclusion that the atoms of the radioactive elements are built up, in part at least, of helium atoms. It is certainly very remarkable and may prove of great significance, that helium, which is regarded from the ordinary chemical standpoint as an inert element, plays such an important part in the constitution of the atoms of uranium, thorium and radium.

The study of radioactivity has not only thrown great light on the character of atomic transformations, but it has also led to the development of methods for detecting the presence of almost infinitesimal quantities of radioactive matter. It has already been pointed out that two methods —one electrical, the other optical—have been devised for the detection of a single α particle. By the use of the optical or scintillation method, it is possible to count with accuracy the number of α particles when only one is expelled per minute. It is not a difficult matter, consequently, to follow the transformation of any radioactive substance in which only one atom breaks up per minute, provided that an α particle accompanies the transformation. In the case of a rapidly changing substance like the actinium emanation, which has a half period of 3.7 seconds, it is possible to detect with certainty the presence, if not of a single atom, at any rate of a few atoms, while the presence of a hundred atoms would in some cases give an inconveniently large effect. The counting of the scintillations affords an exceedingly powerful and direct quantitative method of studying the properties of radioactive substances which expel α particles. Not only is it a simple matter to count the number of α particles which are expelled in any given interval, but it is possible, for example, by suitably arranged experiments to decide whether one, two or more α particles are expelled at the disintegration of a single atom.

The possibility of detection of a single atom of matter has opened up a new field of investigation in the study of discontinuous phenomena. For example, the experimental law of transformation of radioactive matter expresses only the average rate of transformation, but by the aid of the scintillation or electric method it is possible to determine directly by experiment the actual interval between the disintegration of successive atoms and the probability

law of distribution of the α particles about the average value.

Quite apart from the importance of studying radioactive changes, the radiations from active bodies provide very valuable information as to the effects produced by high velocity particles in traversing matter. The three types of radiation, the α, β and γ rays, emitted from active bodies, differ widely in character and their power of penetration of matter. The α particles, for example, are completely stopped by a sheet of notepaper, while the γ rays from radium can be easily detected after traversing twenty centimeters of lead. The differences in the character of the absorption of the radiations are no doubt partly due to the difference in type of the radiation and partly due to the differences of velocity.

The character of the effects produced by the α and β particles is most simply studied in gases. The α particle has such great energy of motion that it plunges through the molecules of the gas in its path, and leaves in its train more than a hundred thousand ionized or dissociated molecules. After traversing a certain distance, the α particle suddenly loses its characteristic properties and vanishes from the ken of our observational methods. It no doubt quickly loses its high velocity, and after its charge has been neutralized becomes a wandering atom of helium. The ionization produced by the α particle appears to consist of the liberation of one or more slow velocity electrons from the molecule, but in the case of complex gases there is no doubt that the act of ionization is accompanied by a chemical dissociation of the molecule itself, although it is difficult to decide whether this dissociation is a primary or secondary effect. The chemical dissociation produced by α particles opens up a wide field of investigation, on which, so far, only a beginning has been made.

The β particle differs from the α particle in its much greater power of penetration of matter, and the very small number of molecules it ionizes compared with the α particle traversing the same path in the gas. It is very easily deflected from its path by encounters with the gas molecules, and there is strong evidence that, unlike the α particle, the β particle can be stopped or entrapped by a molecule when traveling at a very high speed.

When the great energy of motion of the α particle and the small amount of energy absorbed in ionizing a single molecule are taken into consideration, there appears to be no doubt that the α particle, as Bragg pointed out, actually passes through the atom, or rather the sphere of action of the atom which lies in its path. There is, so to speak, no time for the atom to get out of the way of the swiftly moving α particle, but the latter must pass through the atomic system. On this view, the old dictum, no doubt true in most cases, that two bodies can not occupy the same space, no longer holds for atoms of matter if moving at a sufficiently high speed.

There would appear to be little doubt that a careful study of the effects produced by the α or β particle in passing through matter will ultimately throw much further light on the constitution of the atom itself. Work already done shows that the character of the absorption of the radiations is intimately connected with the atomic weights of the elements and their position in the periodic table. One of the most striking effects of the passage of β rays through matter is the scattering of the β particles, *i. e.*, the deflection from their rectilinear path by their encounters with the molecules. It was for some time thought that such a scattering could not be expected to occur in the case of the α particles in consequence of their much greater mass and energy of motion. The

recent experiments of Geiger, however, show that the scattering of the α particles is very marked, and is so great that a small fraction of the α particles, which impinge on a screen of metal, have their velocity reversed in direction and emerge again on the same side. This scattering can be most conveniently studied by the method of scintillations. It can be shown that the deflection of the α particle from its path is quite perceptible after passing through very few atoms of matter. The conclusion is unavoidable that the atom is the seat of an intense electric field, for otherwise it would be impossible to change the direction of the particle in passing over such a minute distance as the diameter of a molecule.

In conclusion, I should like to emphasize the simplicity and directness of the methods of attack on atomic problems opened up by recent discoveries. As we have seen, not only is it a simple matter, for example, to count the number of α particles by the scintillations produced on a zinc sulphide screen, but it is possible to examine directly the deflection of an individual particle in passing through a magnetic or electric field, and to determine the deviation of each particle from a rectilinear path due to encounters with molecules of matter. We can determine directly the mass of each α particle, its charge, and its velocity, and can deduce at once the number of atoms present in a given weight of any known kind of matter. In the light of these and similar direct deductions, based on a minimum amount of assumption, the physicists have, I think, some justification for their faith that they are building on the solid rock of fact, and not, as we are often so solemnly warned by some of our scientific brethren, on the shifting sands of imaginative hypothesis.

E. RUTHERFORD

THE HIGHEST BALLOON ASCENSION IN AMERICA

ALTHOUGH a large number of *ballons-sondes* were despatched from St. Louis in 1904–7 under the direction of the writer (see SCIENCE, Vol. 27, p. 315), none had been employed in the eastern states until last year. In May and July, 1908, four *ballons-sondes* were launched from Pittsfield, Mass., with special precautions to limit the time they remained in the air and so prevent them from drifting out to sea with the upper westerly wind. Three of the registering instruments have been returned to the Blue Hill Observatory with good records. The first instrument sent up on May 7 was not found for ten months and the record, forming the subject of the present article, is very interesting because it gives complete temperature data from the ground up to 17,700 meters, or 11 miles. This is 650 meters higher than the highest ascension from St. Louis, which, by a coincidence, was also the first one to be made there. On May 7 a general storm prevailed, so that the balloon, traveling from the east, was soon lost in the cloud and its subsequent drift could not be followed, but the resultant course was 59 miles from the southwest, as determined by the place where the instrument fell two hours later. At the ground the temperature was 4°.5 C., and this decreased as the balloon rose to the base of the cloud, which itself was considerably warmer than the underlying air. Above the cloud the temperature continued to fall with increasing rapidity up to a height of 12,500 meters (nearly eight miles) where the minimum of —54°.5 C. was registered. Here the great warm stratum was entered and penetrated farther than ever before in this country, namely, to the height of 17,700 meters, where the temperature was —46°.5 C. An increase of 8°.9 occurred, however, in the first 3,000 meters, for above 15,500 meters nearly isothermal conditions prevailed, confirming the belief of Teisserenc de Bort that what he calls the "stratosphere" is composed of a lower inverting layer with isothermal conditions above extending to an unknown height. In an ascension last November in Belgium the

relatively warm stratum was found to extend from 12,900 meters to the enormous height of 29,000 meters, or 18 miles, where there was still no indication of its diminution.

A. LAWRENCE ROTCH

LETTERS FROM CHARLES DARWIN

IN 1882 I published in a history of Pettis County, Missouri, the following:

A flock of geese, belonging to ex-Marshall Kelly, of Sedalia, presents an interesting feature of malformations. In 1873 a gander had one of its wings so injured that it hung horizontally at right angles to the body, in the same manner as is not infrequently seen in other flocks, a result of injuries received. In 1874, one of the young of the flock presented a wing similarly affected; the following year its offspring showed the same features, and this has been continued to the present time. As many as two thirds of the flock have at one time presented this peculiarity, some in both wings. Believing that it was a case of "the inheritance of effects of injuries," Mr. R. A. Blair published an account of it, and sent a copy to Mr. Charles Darwin, and received from him the following letter:

Dear Sir: I am much obliged to you for kindly informing me of the case of the goose. It seems to be a remarkable case of inheritance of effects of injury, and as such cases are very rare, it would be quite worth while to have the facts carefully examined. If you could obtain a wing, and would send it to me, I should be much obliged. The wing might be cut off at the joint with the body, and dried with feathers on, before a hot fire. To make the case of more value, it would be very advisable to ascertain whether the goose had any offspring before the injury, and if so, whether they were normal, and not malformed in any way.

Dear sir, yours faithfully,
CHARLES DARWIN

Mr. Blair then sent a wing of one of the geese, and received the following answer:

Dear Sir: You will think that I have been very neglectful in not having sooner thanked you for the wing of the goose, the photograph, and your last interesting letter; but I thought it best to wait until receiving Professor Flower's report, and you will see by the enclosed the cause of his delay. If you are willing to take the trouble to get your interesting case thoroughly investigated, it will be necessary to procure from the owner the wings of a half dozen birds, some of them quite young; and, if possible, the old one which had his wing broken. They ought to be sent in spirits, and they had better be addressed to Professor Flower, Royal College of Surgeons, Lincoln's Inn Fields, London, and I had better be informed when they are dispatched. Should you be inclined to take so much trouble, I hope you will allow me to say that I should be very glad to pay for the geese, and for the several other contingent expenses. Your first letter and Professor Flower's had better be returned to me hereafter. There is one other point which ought, if possible, to be ascertained, viz: when the old gander had his wing broken, was it wounded so that blood was discharged? If wounded, did the wound suppurate? Did the wing heal quickly or slowly? These are important points in relation to the inheritance of mutilations. Pray accept my best thanks for your kindness, and I remain, Dear Sir,

Yours faithfully,
CHARLES DARWIN

A number of wings were then sent to Dr. Flower, who made a report to Mr. Darwin, in which he says:

The bones, muscles, and ligaments seem quite normal, except for this twisting on their axis, which exactly corresponds, as I mentioned before, to *talipes* or club foot in man. The wings of the very little goslings being dried and very small could not be examined with any good result, but the most curious and unsatisfactory part of the whole thing is that the wing of the old gander, the supposed *fons et origo* of all the mischief, is perfectly normal, and presents no trace of ever having been injured in any way discoverable after the closest examination. It has certainly never been broken or dislocated, though, of course, we can not be sure whether it may not have had a partial twist from which it has now recovered.

With this letter and with the full and detailed report of Dr. Flower's assistant, Mr. Darwin wrote as follows:

Dear Sir: Professor Flower has suffered from a long illness, and this has caused much delay in the examination of the wings of the geese. But I received yesterday his report and letter which I enclose, as you may like to see them. I fear there is no connection between the deformity and the injury. The owner when he saw several goslings thus deformed, a not uncommon form of

quasi inheritance, remembered the accident, and naturally attributed the deformity to this cause. It has been probably a case of "post hoc" and not "propter hoc." I grieve that you should have expended so much time, trouble and great kindness in vain. As for myself I am well accustomed in my experimental work to get definite results but once in three or four times, and thus alone can science prosper. With my renewed thanks, I remain, Dear Sir,

Yours faithfully,

CHARLES DARWIN

The above publication did not give the dates of the letters; however, the first was in 1877 and the last in 1878.

F. A. SAMPSON

COLUMBIA, MO.

LUDWIG RUDOLPH SOPHUS BERGH

LUDWIG RUDOLPH SOPHUS BERGH was born in Copenhagen, October 15, 1824. His father was a military surgeon. Since his family was in moderate circumstances, he undertook at eighteen years of age to support himself during his student life, taking the medical course with zoology and general anatomy under the anatomist Ibsen and the distinguished malacologist Beck. His first paper, published in 1853, was a contribution toward a monograph of the Marseniidæ. In the same year, during the cholera epidemic at Copenhagen, he acted as one of the medical staff formed to combat the ravages of this disease. In 1860 he received his degree of doctor of medicine at the University of Copenhagen, and was appointed three years later head surgeon for dermatology and venerology in the General Hospital; in 1881 professor of these branches in the university, and in 1885 head surgeon in charge of the newly built Vestre Hospital, erected and fitted after his own plans. This responsible position he retained until 1903, when he retired for age; two years later he ceased his private practise, and soon after, by the failure of eyesight, was obliged to relinquish his microscopical researches. He died at Copenhagen, June 20, 1909, leaving a widow and one son, his namesake.

Dr. Bergh for many years stood at the head of the small group of malacological anatomists, devoting himself especially to the Opisthobranchiata and particularly to the group of Nudibranchiata. His published works on these animals form a small library and a mine of detailed information. The chief results of this unremitting labor are summed up in a large quarto in which he gives a complete systematic arrangement for these animals. Beside this contribution to the knowledge of molluscan anatomy he published several valuable memoirs on other groups of mollusks, an especially notable instance being a fine memoir on the anatomy of the genus *Conus*. He was largely concerned with the publication of the great posthumous series of quartos detailing the results of the researches in eastern seas by Carl Semper, who was his intimate friend. In medicine also, his publications, based on the treatment of thousands of hospital patients, took a high rank. He was naturally a member of most European societies and academies concerned in medicine or zoology, and was elected Huxley's successor in the corresponding membership of the Institute of France.

Personally, Dr. Bergh was most genial and agreeable in manner, ever ready to help younger students, or serve as cicerone to foreign colleagues visiting his beloved Copenhagen. Hospitable and unpretentious, a staunch friend and untiring student, his death leaves a gap in the ranks of the veterans which we may hardly hope to see filled, and a memory which those who knew him will cherish long.

WM. H. DALL

SCIENTIFIC NOTES AND NEWS

THE American Astronomical and Astrophysical Society held its tenth annual meeting at the Yerkes Observatory, Williams Bay, Wisconsin, on August 19–21. Fifty members were present and forty-one papers were presented. The following are the officers for the ensuing year: *President*, E. C. Pickering; *First Vice-president*, George C. Comstock; *Second Vice-president*, W. W. Campbell; *Secretary*, W. J. Hussey; *Treasurer*, C. L. Doolittle; *Members of the Council*, W. J.

Humphreys, Frank Schlesinger, W. S. Eichelberger, E. B. Frost.

DR. C. M. GARIEL, professor of medical physics at Paris, has been elected president of the French Association for the Advancement of Science for the meeting to be held next year at Toulouse.

AMONG those who were given doctorates of philosophy at the recent Leipzig celebration are Sir Archibald Geikie, the geologist, and Dr. James Ward, professor of philosophy at Cambridge.

DR. HARVEY CUSHING, of the Johns Hopkins University, gave the William Banks memorial lecture at the University of Liverpool on August 4. He treated the pathology and surgery of intracranial tumor.

THE German Association of Men of Science and Physicians has awarded the income ($750) of the Trenkle Foundation to Dr. F. Harms, of Würzburg, for his work on the electromagnetic theory.

MR. EDW. M. EHRHORN, at present deputy horticultural commissioner of California, has accepted the appointment of superintendent of entomology of the Hawaiian Board of Agriculture beginning on October 1. Mr. Jacob Kotinsky resumes the post of assistant entomologist with the board.

DR. ARNOLD RUGER, of Heidelberg, proposes to edit a year book of philosophy, and will be glad to receive copies of papers bearing on philosophy, psychology, logic, ethics and esthetics, which should be sent care of Weiss'chen Universitäts Buchhandlung, Heidelberg.

MR. CHARLES LOUIS POLLARD, curator-in-chief of the Museum of the Staten Island Association of Arts and Sciences, and Mr. George P. Engelhardt, assistant curator in the Children's Museum of the Brooklyn Institute of Arts and Sciences, have returned from a field trip in North Carolina. They explored Roanoke Island and Smith's Island and also paid a brief visit to the mountains in the vicinity of Blowing Rock and Linville Falls. A large collection of insects and some reptiles and batrachians were obtained.

ON August 17, Mr. Carl E. Akeley, formerly of the Field Museum of Natural History, and Mrs. Akeley sailed *en route* for British East Africa. This is the third trip in the interest of science, the two former ones being for the Field Museum and the present one for the American Museum of Natural History. The expedition will require two years and besides obtaining a group of elephants to be mounted amid a reproduction of their natural habitat in the American Museum, much time will be spent in making a very complete photographic record of the people, fauna and flora. A moving picture camera is being taken and pictures of army ants on the march and other movements of animals will be attempted. Mr. Akeley has just completed the new elephant group at the Field Museum and was the creator of the well-known deer group also in the Chicago institution.

UNDER the presidency of the United States ambassador, Professor Osler will deliver the inaugural address of the winter session of the London School of Tropical Medicine on October 26.

DR. EARL LOTHROP has been elected president, and Dr. Harry R. Trick, secretary, of the Buffalo Academy of Medicine.

THE Wesley M. Carpenter lecture for 1909 before the New York Academy of Medicine will be delivered on October 21 by Dr. H. T. Ricketts, professor of pathology in the University of Chicago, on "Some Aspects of Rocky Mountain Spotted (Tick) Fever, as shown by Recent Investigations." The anniversary address, on November 18, will be made by Dr. Louis Livingston Seaman, late major and surgeon, U. S. Engineer Corps, on "Personal Observations on the Sleeping Sickness in Central Africa."

DR. WILLIAM BRODIE, biologist of the Provincial Museum of Toronto, who had made valuable entomological and other biological collections, died on August 6, at the age of seventy-eight years.

PROFESSOR EMIL HANSEN, the eminent physiological botanist, known especially for his work on microorganisms and alcoholic ferments, died on August 27, at the age of sixty-seven years.

Mr. William Ford Stanley, the maker of scientific instruments and author of contributions to physical and astronomical science, died on August 14, at the age of eighty-one years. Mr. Stanley built and endowed the Stanley Technical Trade Schools at Norwood.

Dr. Viktor Kremser, chief of division of the Meteorological Institute of Berlin, has died at the age of fifty-one years.

Mrs. Nelson Morris has endowed with $250,000 an institution in Chicago to be called the Nelson Morris Memorial Institute of Medical Research. It will be connected with the Michael Reese Hospital, of which Dr. John Hormsby is the superintendent and Dr. James W. Jobling chief pathologist. Dr. Jobling will direct the scientific work of the institute.

The Dallas (Texas) Medical and Surgical Building Association has been organized to erect an office building to be devoted to professional men entirely and to cost $500,000.

The Public Health and Marine-Hospital Service has taken steps looking to the establishment of a branch of its Federal Laboratory on the Pacific coast in the zone of squirrel plague infection.

The general assembly of Georgia has through the initiative of Dr. A. M. Soule, president of the State Agricultural College, appropriated $10,000 for educational work at farmers' institutes throughout the state.

The fourth International Congress of Aeronautics will be held from September 18 to 24 at Nancy. Proceedings will be divided into three main sections: (1) aerostation, (2) aviation, (3) legislation and general subjects.

A telegram has been received at the Harvard College Observatory from Professor H. Kobold of Kiel, stating that Perrine's comet was observed by Kopff August 12.42.99 G.M.T. in R.A. $0^h 17^m 8^s$ Dec. $+35° 32'$. The object is visible in a large telescope.

It appears from the daily papers that at the meeting of the Association of State and National Food and Dairy Departments, at Denver on August 26, a vote of 57 to 42 was passed in favor of the following resolution:

Resolved, That this association hereby indorses the report of the Referee Board of Consulting Scientific Experts, appointed by Secretary of Agriculture Wilson at the direction of President Roosevelt upon the use of benzoate of soda in food products.

According to press despatches, valuable deposits of radium-bearing pitchblende have been discovered on the McCloud River, Cal. It is also reported that pitchblende has been discovered in Cripple Creek district of Colorado.

President Taft has issued a proclamation setting aside the Oregon caves in the Siskiyou National Forest in the state of Oregon as a national monument. The area of the reservation is about four hundred and eighty acres.

The department of plant pathology of the New York State College of Agriculture at Cornell University, Ithaca, N. Y., announces the establishment of a temporary industrial fellowship by the Niagara Sprayer Company of Middleport, N. Y. The purpose of this fellowship is to investigate the value of commercial lime-sulphur mixtures as fungicides. The fellowship is established for two years at a salary of $1,000 a year, and with a maximum sum of $500 annually, for the carrying on of the investigations. By the terms of the fellowship the College of Agriculture is left perfectly free to carry on the investigations in any way it may see fit, and to freely publish all the results at any time. Mr. Errett Wallace (Cornell, B.S.A. '08, M.S.A. '09) has been elected to the fellowship. The investigations will be conducted in field laboratories, situated somewhere in the state of New York. The work for the present season is being conducted on the fruit farm of Mr. L. B. Frear, near Ithaca, N. Y. The chief problem for investigation at present is to determine the efficiency of the commercial lime-sulphur mixtures as a summer spray for the control of peach and apple diseases.

It is reported by cable that the debt incurred by Lieutenant E. H. Shackleton and the members of the family for his Antarctic expedition is to be liquidated by the government. Premier Asquith has announced in the

House of Commons that he would ask the house to vote $100,000 for that purpose. Previously Mr. Shackleton had issued a statement in which he said:

When, after great difficulty, I had secured sufficient promises of support to enable me to announce the expedition on February 12, 1907, I proceeded to make my preparations with a view to leaving England in July of that year. My supporters were various relatives and friends in this country—not in the United States as has been declared—but, owing to the American financial crisis and the resulting financial stringency in this country, some of the money promised to me did not become available. When I found that the promises of support could not be carried out, I went to several rich men, and they very generously guaranteed me at the bank to the extent of £20,000, on the understanding that the guarantees were to be paid off by me not later than July, 1910. The arrangement was that the bank should advance the money on the guarantees and that I should pay interest. I can not thank too warmly those who had faith in me when comparatively unknown. When I arrived in Australia on my way south, I made application to the Commonwealth government for assistance, and I was at once given a sum of £5,000 for the purposes of the expedition. The New Zealand government further gave me £1,000, paid half the cost of towing the *Nimrod* to the Antarctic, and assisted me in various other directions. This sum of £6,000 enabled me to increase my staff and to secure additional stores and scientific equipment. The position now is that the guarantees to the extent of £20,000 have to be released, and this, I hope, will be done by the sale of my book and by my lectures and the money that my wife's relatives and myself and friends have contributed. Apart from this, of course, the cost of the expedition was far in excess of £20,000. I should like it clearly understood that since my return I have not approached his majesty's government in the matter and it can not justly be said, therefore, that they have declined to contribute.

UNIVERSITY AND EDUCATIONAL NEWS

ILLINOIS WESLEYAN UNIVERSITY has received $30,000 from Mr. Andrew Carnegie for a new science building.

MR. NEIL MACNEIL, of Boston, has presented to St. Francis Xavier's College, Nova Scotia, for the use of its professors, a seaside resort—a block of land with a completely equipped summer home—at Mahanny's Beach, on the shore of Bay St. George.

MRS. ELIZABETH MURDOCK, the widow of a Liverpool shipowner, has bequeathed £2,000 to the University of Liverpool to found engineering scholarships.

THE College of Physicians and Surgeons of Los Angeles has consolidated with the College of Medicine of the University of Southern California. The name of the consolidated school will be College of Physicians and Surgeons, Medical Department of the University of Southern California.

THE Hong-kong and Shanghai Bank has made a donation of £4,500 for the Hong-kong University.

THE governor of Madras opened on July 14 a new agricultural college and research institute at Coimbatore. Rooms are provided for chemistry, physics, botany, entomology and mycology.

EDINBURGH UNIVERSITY has decided to send its scholarship men to the Iowa State College to pursue graduate work in animal husbandry. Two of these men are now on their way from Scotland.

DR. J. H. KASTLE, chief of the division of chemistry of the Hygienic Laboratory of the U. S. Public Health and Marine Hospital Service, will at the opening of the academic year assume the duties of professor of chemistry at the University of Virginia. Dr. J. W. Mallet, professor of chemistry since 1885, who will celebrate his seventy-seventh birthday on October 10, has been made professor emeritus under the Carnegie Foundation.

MR. MELVIN E. SHERWIN, instructor in astronomy in the University of California, has been appointed assistant professor of astronomy in the University of Maine.

MR. W. H. HADOW, fellow and tutor of Worcester College, Oxford, has been appointed principal of Armstrong College of Durham University at Newcastle-on-Tyne, in succession to Sir Isambard Owen, who has accepted the vice-chancellorship of Bristol University.

DISCUSSION AND CORRESPONDENCE

ON THE INHERITANCE OF ANILINE DYE

In one of the German magazines I have found a short account of Dr. Riddle's work, "On the Inheritance of Aniline Dye," published in SCIENCE. Dr. Riddle showed that the yolks and embryos of the eggs laid by hens which were fed with the dye Sudan III. were colored. As in the account the remark is made that since the year 1896, when an Italian, Daddi, discovered that Sudan III., given as nourishment, possesses a staining power, no one has undertaken any further experiments upon animals with this dye, I should like to state that my experiments carried out in Professor Dr. Hoyer's laboratory, and entitled, "Contribution à la biologie des teignes," were already published in the year 1905 in the "Bulletin intern. de l'Academie des Sciences de Cracovie, 1905."

Giving wool together with the dye Sudan III. as food to the caterpillars of a certain moth (*Tineola bisselliolla* Hummel), I caused their bodies to be colored red. Their adipose tissue was the most intensely stained. The larvæ thus colored undergo normal metamorphosis, the pupæ and also the butterflies produced from them continue to preserve the typical red color of Sudan. The tinge of the head, thorax, abdomen and limbs of a butterfly may be easily seen with the naked eye beneath the scales covering the body. In general this coloring makes its appearance where adipose tissue is present. There is also an accumulation of dye in the female's ovary. In the cells surrounding an egg there are seen small drops of fat stained with Sudan. The eggs laid afterwards look reddish and the drops of fat contained in them have the very characteristic color of Sudan. Thus, by feeding the larvæ of one generation with Sudan, I obtained all the stages of development of the moth colored with the same dye, and this dye was later transferred into the reproductive cells of the same generation. From all this we may conclude that the reserve material accumulated by a larva in the form of fat serves not only for one stage of development, but is also transferred almost without change and is of use in the further development of the insect. Besides, the dye, introduced into the organism of an individual as a material admixture, is transmitted by means of the reproductive cells to the offspring and in this manner it may be inherited.

In later researches, the results of which are not yet published, I have proved that larvæ, hatched from eggs colored with Sudan, possess its special tinge of red. I have also succeeded in obtaining similar results, when using a series of dyes of different colors, *e. g.*, blue, and in experimenting with different kinds of butterflies and other insects.

LUDWIK SITOWSKI

NON-FRUITING OF JAPAN PERSIMMONS DUE TO LACK OF POLLEN

SINCE its introduction in the seventies, the Japan persimmon has received a considerable amount of attention from growers and investigators. Its culture has gradually increased until it is now cultivated to a greater or less extent over a fairly wide area, a section corresponding roughly with that in which cotton can be produced.

Complaint has many times been made that the Japan persimmon does not hold its fruit, that it blooms profusely, but the young fruits drop off shortly after the flowering period is past; in fact, at this time, each season, the ground under large trees is often literally covered with the calyces and ovaries of the plant. At harvest time, either not a single fruit remains or only a few scattered specimens on trees which should have borne bushels of luscious fruit.

Various reasons have been given for this phenomenon, such as lack of necessary food supply, lack of moisture or uncongenial soils, and the remedies suggested and most frequently put into effect have been more frequent cultivation, no cultivation at all and heavy applications of fertilizers, particularly potash; but in spite of all these, the Japan persimmon has continued to behave in much the same way, some varieties holding a fair crop, others none, bearing one year and not another. There has always been something

extremely erratic in their behavior. It would appear that the problem is not one of cultivation or fertilization and the cause and remedy must be sought in an entirely different direction.

While it is a fact, well known to botanists, that plants of the genus *Diospyros* are diœcious (occasionally polymorphous or monœcious), yet the question of sex as related to the non-fruiting of the Japan persimmon, *D. Kaki*, appears to have been entirely overlooked. Examination, both macroscopical and microscopical, of hundreds of flowers of different varieties shows that the stamens in the pistillate flowers are abortive and no pollen is borne in them. Without question, herein lies the reason for Japan persimmons so often setting no fruit, or only a very light crop—an abundant supply of pollen at the proper time is lacking and the only source of pollen for the Japan persimmon is the chance supply furnished by staminate trees of *D. Virginiana*. So far as the records show, no male trees of *D. Kaki* have been brought to this country. A change in orchard practise is needed, and as in the culture of Smyrna figs or dates, carob bean and pistache nut, the planting of male trees to supply pollen is a necessity, so in orchards of Japan or other persimmons, the presence of male persimmon trees, covering the blooming period, is necessary to secure an abundant setting of fruit. To this there are doubtless exceptions, as some varieties (Tane-Nashi, for instance) are almost invariably seedless and apparently set and mature fruit without being pollinated. Seedlessness is in many cases due to environment and is not an inherent character in fruits. It is often due simply to lack of pollen.

It is possible that some specimens of *D. Kaki* in this country do produce pollen-bearing flowers, but such trees are extremely rare, and in ten years of observation, but one such tree, a monœcious specimen of Tabers No. 23 has been noted. So infrequently do such occur, it may not be too much to say that all Japan persimmon seedlings originated in this country have a strain of some other persimmon (usually *D. Virginiana*) in them.

The problems connected with this matter are being carefully investigated.

H. HAROLD HUME

GLEN SAINT MARY, FLORIDA,
May 10, 1909

SCIENTIFIC BOOKS

The Rise and Progress of the British Explosives Industry. Published under the auspices of the Seventh International Congress of Applied Chemistry by its Explosives Section. Small quarto; pp. 418; 39 illustrations. New York, Whittaker and Co. 1909.

This is the first fruit of the congress held in London, May 28 to June 2, 1909, which was attended by some 3,000 members. This book originated in a suggestion made to the Committee of the Explosives Section, which has financed the project, on December 5, 1908, and it is the product of the joint efforts of a large number of collaborators, most of whom are intimately connected with the special branches of the industry of which they treat, under the supervision of Mr. E. A. Brayley Hodgetts, editor. The contents are classified into an Historical Part, treating of gunpowder, nitrocellulose, nitroglycerine and its derivatives, permitted explosives, percussion caps, Bickford's safety fuse, fireworks, legislation, bibliography, chronology and list of gunpowder makers; and a Descriptive Part, treating of the three existing government establishments and some fifty-four private establishments.

The bibliography and chronology fill some 132 pages, while there are, in addition, considerable lists of papers and patents attached to some of the special articles, and these are quite useful, but the special articles, as might be expected from so large a number of contributors, and especially where so many of them are engaged in other than literary or scientific pursuits, exhibit a marked unevenness in the method of treatment and the quality of the product. This lack of system is especially to be noted in the part devoted to private establishments where the accounts vary from a two-line notice of one establishment to a ten-page description of another.

In fact, a large part of the text could have

been omitted without serious loss, yet the research student must examine it in detail, since there occurs from time to time statements such as "This 'heat test,' as it was called, invented and perfected by the late Dr. Dupré, chemical adviser to the home office, is in universal use to-day: it is a test for the purity of guncotton, nitroglycerine and freshly made explosives, and the home office has so far found nothing to supersede it," for from 1896, at least, when P. Gerald Sanford published his "Nitro-Explosives" in London, to 1909, when Dr. H. Kast published his "Anleitung zur chemischen und physikalischen Untersuchung der Spreng- und Zündstoffe" in Brunswick, this stability test has been almost universally styled the Abel heat test, and in view of such governmental publications as that issued from Woolwich, under date of February 11, 1874, it has seemed proper to do so, but of course we must recognize the primary right of the English people to determine questions of priority between their own investigators. They should, however, also resolve the conflicting claims to invention and ownership of modern explosives set forth in these pages by the representatives of private establishments.

As indicated above, the book is a disappointing one and most so in the matter of statistics, for while the rise of an industry in its various phases may be set forth chronologically, the progress is to be measured quantitatively, and yet one searches these pages in vain for the quantities of the explosives of various kinds produced at different periods. It is true that the report of the Nobel's Explosives Company, Limited, shows that, starting in 1871 with a capital of £24,000, it accumulated reserves which were capitalized in 1900 at £800,000, in addition to which debentures to the value of £500,000 were issued, and that, by 1909, it owned nine factories, the chief one known as the Ardeer Factory, occupying 837 acres, containing 1,004 buildings, and employing 2,300 foremen and laborers, together with 35 chemists. Had the editor arranged a system of reporting whereby the other establishments made returns of items similar to these just cited, some measure of progress would have been presented.

In one regard the book is a surprise, for claims to preeminence are set forth in it in no uncertain tones and it may be read with comfort by Americans who are restive under foreign criticism. In fact, in many regards, the book suggests those which may be found in hotels and on routes of travel frequented by commercial travelers.

CHARLES E. MUNROE

Phrenology or the Doctrine of the Mental Phenomena. By J. G. SPURZHEIM. Revised edition from the second American edition, published in Boston, 1833. With an introduction by CYRUS ELDER. Philadelphia and London, J. B. Lippincott and Company. 1908.

This is a reprint, without change in the text, except the omission of Spurzheim's reflections upon the moral and religious constitution of man, his voluminous Latin notes and a controversy with George Combe, of the antiquated "phrenology" which sought to define the intellectual and affective powers of the mind, be they perceptive or reflective, propensities or sentiments, in terms of parts that can be distinguished by the external configuration of the head. A frontispiece shows the familiar charts of the head in three views, setting forth with great thoroughness the location of each and all of the powers of the mind. Fourteen plates show portraits of men, bull-dogs and horses, with "readings" of the various "organs" indicating *destructiveness, amativeness, philoprogenitiveness, inhabitiveness, benevolence, ideality* and so on.

Phrenology has had its day, of even shorter duration than alchemy or astrology, alike empiric and mystic, though it can not be denied that Gall and Spurzheim, particularly the former, did much to prepare the foundation for the rising superstructure of proved facts regarding the brain and mind. Even modern attempts to revert to phrenology and phrenologic methods in localizing the passions and emotions—that is, the subtle moral qualities as distinguished from the intellect—such as the pretentious work of Bernard Holländer have failed signally to convince.

One is curious to know why such an obsolete work was deemed worthy of reprinting at this time and after the lapse of more than sixty years. Cyrus Elder, who writes the introduction, is evidently a layman in matters anatomic and psychologic and therefore doughtily attacks the doctor of medicine and the psychologist as knowing nothing of the mind in the one case and nothing of the brain in the other. Mr. Elder is either innocent of knowledge of, or he ignores the results of, patient researches conducted along clinico-pathologic, experimental, physiologic and developmental lines which have furnished us with a good working map of the somesthetic and sense-areas and, inferentially, of the association-areas of the cerebral cortex. But even such a topographic map, delineating areas called *motor, visual, auditory* and so on, is not to be considered as mathematically accurate or sharply defined as the areas of a state, county or township. The areas rather shade off in a diffuse manner and really show only the maximum concentration of those cortical parts which most distinctly appertain to the function alleged for them. Also, while less than one third of the cortical expanse is directly concerned with receptive and emissive functions, the remainder is presumed to be devoted to the elaboration of the higher mental activities manifested in abstract thought, ideation, reasoning and language. Further than this, present-day cerebral localization of function in the cortex does not pretend to go. Although an aggregation of psychic areas and therefore the seat of the will, the neuronic connections of any portion of the cortex with other cortical parts and of these with other centers in the brain, are so intricate, complex and interdependent that all search for isolated "centers" of moral qualities, qualities of consciousness, has thus far been quite futile. Of the neurone, the developmental, structural and functional unit of the nerve-system, and of the grouping and chaining of neurones as revealed by modern methods of investigation, Gall and Spurzheim knew nothing, of course; apparently the editor of the volume before us is no better off.

With the increase of the intellectual faculties in the course of evolution, the brain has developed in bulk and complexity and with it the skull has undergone expansion and modification of form. Some of the intellectual faculties have found somatic expression in the relative expanse of certain cortical areas and these in turn have exerted some influence upon the configuration of the skull, but not to the degree nor of the same kind of protuberances that Gall and Spurzheim's phrenology proposed; protuberances, by the way, which in certain instances overlie normally variant air-sinuses, blood-sinuses, sutural thickenings or muscle.

Unless it be that a certain historic interest attaches to a work which for a time attracted attention and even afforded disciples of its doctrines a means of livelihood, and which may be regarded as a stepping-stone toward modern cerebral physiology, the reprinting of Spurzheim's work must be regarded as a somewhat otiose undertaking.

EDW. ANTHONY SPITZKA
JEFFERSON MEDICAL COLLEGE,

SCIENTIFIC JOURNALS AND ARTICLES

The Journal of Biological Chemistry, Vol. VI., No. 3, June, 1909, contains "The Mode of Oxidation in the Organism of Phenyl Derivatives of the Fatty Acids": Part IV., Further Studies on the Fate of Phenylpropionic Acid and Some of its Derivatives; Part V., Studies on the Fate of Phenylvaleric Acid and its Derivatives; Part VI., The Fate of Phenylalanine, Phenyl-β-alanine, Phenylserine, Phenylglyceric Acids and Phenylacetaldehyde, by H. D. Dakin. These papers are a continuation of the author's earlier work on the mode of catabolism of fatty acids. They show the stages through which the substances studied pass in their transformation in the body and lead to the view that the catabolism of a fatty acid group is effected by the removal of two carbon groups at a time. This process is termed by the author "successive β-oxidation" and is believed to be a general biochemical reaction. "The Nuclein Ferments of Yeast," by M. N.

Straughn and Walter Jones. Yeast contains guanase but not adenase or xanthoöxidase. "Further Studies on the Use of the Fermentation Tube in Intestinal Bacteriology," by A. I. Kendall. Explanations of commonly observed discrepancies in the study of intestinal flora by means of the fermentation tube. "The Metabolism of Man during the Work of Typewriting," by Thorne M. Carpenter and Francis G. Benedict. Estimations of oxygen consumption, carbon dioxide exhalation and heat production show that the energy transformation during the work of typewriting is less than that occurring in ordinary walking.

SPECIAL ARTICLES

A SUCCESSFUL OVARIAN TRANSPLANTATION IN THE GUINEA-PIG, AND ITS BEARING ON PROBLEMS OF GENETICS[1]

TRANSPLANTATION of the ovary from one animal to another has often been attempted, and with varying degrees of success. The object has usually been to observe the effects of the transplantation upon the animal into which the foreign ovary was introduced. Recently, however, the experiment has been repeated by students of genetics, to discover, if possible, what the effect would be upon the germ-cells, of a transfer from their normal environment to the body of a different individual. The most noteworthy results thus far[2] reported are those of Guthrie on hens, and of Magnus[3] on rabbits. Each apparently working without knowledge of the other's work has obtained what seems to be a modification of the coloration of the offspring, due to influence exerted by the foster-mother upon the germ-cells liberated within her body from the introduced ovary. But in the work of neither of these experimenters does the nature of the result obtained preclude the possibility that the ova liberated may have come from regenerated ovarian tissue of the mother herself rather than from introduced ovarian tissue. The theoretical importance of this point led us about a year ago to plan experiments which should not be open to the objection which we have stated. We therefore undertook the transfer of ovarian tissue from a Mendelian dominant to a Mendelian recessive individual. For if in such a case germ-cells were liberated which bore the dominant character, we should know that they could have come only from the introduced tissue, since recessive individuals are themselves incapable of liberating dominant germ-cells.

We are now able to report partial success. The ovaries were removed from an albino guinea-pig about five months old, and in their stead were introduced the ovaries of a black guinea-pig about one month old. The albino upon which the operation had been performed was then placed with an albino male guinea-pig, and six months later bore two black-pigmented young.

In all recorded observations upon albino guinea-pigs, of which we have ourselves made many hundred, albinos when mated with each other produce only albino young. Accordingly there seems no room for doubt that in the case described the black-pigmented young derived their color, not from the albino which bore them, but from the month-old black animal which furnished the undeveloped ovaries, for transplantation into the albino. As regards the important question whether, in such an experiment as this, the germ-cells are modified in character by the changed environment within which they are made to grow, our results are at variance with those of Guthrie and Magnus. *We can detect no modification.* The young are such as might have been produced by the black guinea-pig herself, had she been allowed to grow to maturity and been mated with the albino male used in the experiment.

We have now under observation about seventy-five other guinea-pigs, as well as a number of rabbits, upon which similar operations have been performed. From some of these we hope to obtain further results.

[1] Contributions from the Laboratory of Genetics, Bussey Institution, Harvard University, No. 1.

[2] *Journal of Experimental Zoology*, Vol. 5, p. 563, June, 1908.

[3] *Norsk magazin for lægevidenskaben*, No. 9, 1907.

We are indebted to Dr. Alexis Carrel, of the Rockefeller Institute, for valuable suggestions as to operative technique, and to the Carnegie Institution of Washington for material assistance through a grant to the senior author.

W. E. CASTLE,
JOHN C. PHILLIPS
FOREST HILLS, BOSTON, MASS.,
August 11, 1909

THE PECULIAR INHERITANCE OF PINK EYES AMONG COLORED MICE[1]

READERS of SCIENCE are well acquainted with the fact that color-inheritance in mice presents many difficult problems. To one of these problems we are hopeful that we have found a solution. Mice occur in the same fundamental color-varieties as guinea-pigs, most of which are found also among rabbits.[2] These color varieties occur in two series, one the usual or intense series, the other a dilute or pale series. Bateson (1909) considers the pale series a quantitative modification merely of the intense series, but there are some reasons for regarding it as a qualitative modification. But whichever it may prove to be, the dilution is demonstrably interchangeable from one color variety to another, so that it may conveniently be treated as due to an independent factor.

Mice are peculiar in that they possess another series of color varieties, or really two other series, as we shall try to show, not found in mammals generally.

In this series the eye is apparently pink, but in reality, as Miss Durham has shown, it is very slightly black or brown pigmented. Further, black or brown pigments of the coat, if present, are pale in pink-eyed mice.

We find, however, that the paleness of the pigments in such cases is not commonly due to the same factor as the paleness of coat in the dilute series having dark eyes, but to a different factor which may or may not be associated with the dilution factor and which we regard as a *quantitative* modification of the pigmentation, while the dilution may be regarded as a *qualitative* modification of it.

We recognize, accordingly, four series of color varieties among mice, two dark-eyed and two pink-eyed. Dark-eyed and pink-eyed may each occur in an intense series and in a dilute series. The reason that they have not been recognized sooner is that the intense pink-eyed animal is really less heavily pigmented than the dilute dark-eyed animal of the same color-type, and so *all* pink-eyed animals have been considered *dilute*. But that such is not the case is shown by the following experiment. If a pink-eyed gray (intense) animal is mated with a dark-eyed pale cinnamon (dilute) the young are all both dark-eyed and intense; namely, the color of wild house-mice (gray).

Now if such grays are bred together they produce: (1) grays (both intense and dark-eyed); (2) blue-grays (dilute and dark-eyed); (3) pink-eyed grays (intense but with reduced amount of pigment), and (4) pink-eyed pale-grays (dilute and with reduced amount of pigment). Manifestly this is a case of Mendelian dihybridism, in which the pigmentation has been modified in two different ways. Each modification affects the fundamental color-factor, C, and may be transmitted through albinos, or from one color variety to another. For convenience of reference we place in a table the names of the four series of color-varieties which we recognize. Most of these have already been identified but there is still uncertainty about a few of them. In the table p. means pink-eyed as well as "paucity" of black or brown pigment in the coat.

The albinos being wholly unpigmented are indistinguishable in the several series except by breeding tests.

A specific experiment illustrative of the foregoing account, though involving a greater number of factors, is the following.

[1] Contributions from the Laboratory of Genetics, Bussey Institution, Harvard University, No. 2.

[2] See SCIENCE, January 25, 1907; August 30, 1907; August 21, 1908.

[3] The coat looks to the unaided eye very similar to that of the dark-eyed pale cinnamon.

[4] This variety has a coat much less heavily pigmented than the dark-eyed blue, but if crossed with cream it produces black and gray young, not blue and blue-gray.

Series 1 Dark-eyed Intense	Series 2 Dark-eyed Dilute	Series 3 Pink-eyed Intense	Series 4 Pink-eyed Dilute
Gray	Blue-gray	p. Gray[3]	p. Pale gray
Black	Blue	p. Blue[4]	p. Pale blue
Cinnamon	Pale cinnamon	p. Cinnamon	p. Pale cinnamon
Chocolate	Pale chocolate	p. Lilac	p. Pale lilac
Yellow	Cream	p. Yellow	p. Cream
Albino	Albino	Albino	Albino

A *dilute* dark-eyed cinnamon ♀ 682 was mated with a *pink-eyed* gray ♂ 691. From this mating fifteen young were obtained, all *intense* dark-eyed grays (like the wild house-mouse).

From these grays, when bred together, there have been obtained up to the present time fifteen young of at least six different color varieties distributed as shown below. On the hypothesis, which we have advanced, the expected number of varieties is eight; their expected frequencies in a total of sixty-four young are also shown below. It is not surprising that, in so small a number of young as fifteen, two of the smallest of the expected classes should be unrepresented, but it is not yet certain that they are unrepresented, since the visible difference between p. cinnamons and p. grays is probably so slight that breeding tests may be required to differentiate the two classes.

	Dark-eyed				Pink-eyed			
	gray (intense)	blue gray (dilute)	cinnamon (intense)	pale cinnamon (dilute)	p. gray (intense)	p. pale gray (dilute)	p. cinnamon (intense)	p. pale cinnamon (dilute)
Expected	27	9	9	3	9	3	3	1
Actual	4	3	2	1	4?	1?	?	?

The cross is evidently one involving three independent Mendelian factors, viz., (1) black *vs.* brown pigmentation; (2) intense *vs.* dilute pigmentation; and (3) dark-eyed *vs.* pink-eyed (or, as we should prefer to call it, the full amount of pigment *vs.* a reduced amount).

The known Mendelian factors concerned in the color variation of mice now number nine. They are:

1. *C*, the general *color* factor, the basis of all pigment in the skin and coat; its three modifications follow next.
2. *d*, the *dilution* factor.
3. *s*, the factor which causes *spotting* with white.
4. *p*, the *pink-eye* (or *paucity*) factor; next follow the three specific color factors and their two modifiers.
5. *Y*, the *yellow* factor.
6. *Br*, the *brown* or chocolate factor.
7. *B*, the *black* factor.
8. *R*, the *restriction* factor, which when present restricts black and brown pigments to the eye and leaves the coat yellow.
9. *A*, the *agouti* factor which operates by excluding black and brown pigments from particular parts of the hair, thus producing the ticked gray or cinnamon coat.

An explanation of the symbols chosen to express these factors will be given elsewhere.

Grateful acknowledgment is made of assistance rendered by the Carnegie Institution of Washington through a grant to the senior author.

W. E. CASTLE,
C. C. LITTLE
FOREST HILLS, BOSTON, MASS.,
August 11, 1909

THE FORTIETH GENERAL MEETING OF THE AMERICAN CHEMICAL SOCIETY. III

DIVISION OF PHYSICAL AND INORGANIC CHEMISTS

Charles H. Herty, chairman

Wilder D. Bancroft, secretary

On the Volumetric Estimation of Uranium and Vanadium: EDWARD DEMILLE CAMPBELL and CHAS. E. GRIFFIN.

A brief review of the methods previously published is given. Experiments show that vanadium may be satisfactorily determined by reduction with sulphur dioxide and titration with permanganate and vanadium and uranium together may

be reduced by boiling with a spiral of heavy aluminum wire and titration with permanganate after the removal of the aluminum wire spiral and addition of excess of ferric sulphate.

In the analysis of carnotite ore after solution of the ore in nitric acid and evaporation with sulphuric acid the vanadium and uranium are separated from iron by double precipitation of the latter with sodium carbonate in the presence of a little hydrogen peroxide. In the acidified solution the vanadium is first determined by reduction with sulphur dioxide to V_2O_4 and titration with standard permanganate, after which the vanadium is reduced by boiling with aluminum to V_2O_3 and the uranium to UO_2. After complete reduction of the uranium and vanadium acidified ferric sulphate is added and the solution titrated with standard permanganate.

The Development of Positives after Short Exposures: WILDER D. BANCROFT.

If we expose a plate for ten minutes on a sunny day, the plate will develop as a positive instead of a negative. The theory of this phenomenon is quite simple and I need not go into it now. My problem to-day is how to produce the same result with a short exposure in the camera as with a long one, and we have worked out three methods of doing this.

The first way is to make the plate much more sensitive to light. This can be done by dipping the plate in a developer solution and exposing it wet. The light acts in the presence of a powerful depolarizer, the developer, and in consequence the chemical action is much greater for a given exposure. Incidentally, this method can also be used for shortening the exposure necessary to produce a negative.

The second way is to expose the plate after it has been in the camera to a uniform light for a short time. Since the sensitiveness of the plate to light of a given wave-length changes during the exposure, we can change the amount of contrast by changing the color of the fogging light. A more satisfactory result is obtained with a greenish-blue light rather than by the white light which has ordinarily been used. Since the intensity of the fogging light is greater at the air side of the film than at the glass side, the decomposition of the silver bromide is consequently greater there. By use of a suitable developer, we have succeeded in developing a plate so that there is a positive image on the air side and a negative image on the glass side.

The third method is that of a slow reduction before development. If the films in a kodak are not developed until several months after the exposure, there is always the possibility of their developing as positives. This is undoubtedly due to slow decomposition of the film which reduces the silver bromide to a lower stage and therefore duplicates the effect of a longer exposure. We have produced the same effect in the laboratory under somewhat definite conditions. The plate is left for a long time in a very weak developer and is then treated with an ordinary developer. As was predicted, the plate develops as a positive under these circumstances.

A fourth method is to add sulpho-urea to the developer as suggested by Waterhouse. This method gives beautiful positives; but we are not yet certain as to the theory and we are still working at this.

The Condensation of Water by a Substance in Solution: F. K. CAMERON and W. O. ROBINSON.

The condensation of water due to the presence of dissolved electrolytes is calculated from accurate specific gravity determinations on solutions of concentrations below 0.1 normal. In the cases of solutions of hydrochloric and nitric acids the concentration-condensation curves pass through maximum points. The investigation was undertaken primarily to find the effect of condensation, by a substance in solution, on suspensions and flocculation, but no generalizations of a causal character can be made from the data obtained.

The Dielectric Constants of some Inorganic Solvents: OSCAR C. SCHAEFER and HERMAN SCHLUNDT.

This communication is a continuation of the earlier work of Schlundt on the dielectric constants of inorganic solvents. The values obtained for the three halogen hydrides—hydrogen iodide, hydrogen bromide, hydrogen chloride—have been determined. The value of the dielectric constant of solid hydrogen cyanide is also reported as new value, that of the liquid having been published some years ago.

Solvents for Use with the Munroe Crucible: OTIS D. SWEET.

About forty-five solvents are enumerated. A table including about 120 precipitates and the corresponding solvents is also given.

Organic Amalgams: H. N. McCOY and W. C. MOORE.

Discoveries in radioactivity in the last decade clearly show that some, at least, of the metallic

elements are not permanent, but disintegrate spontaneously, forming other elements. On the other hand, many organic radicles behave like elements, passing unchanged through many transformations. The ammonium radicle, in the form of ammonium amalgam, has marked metallic properties. We have made other amalgams of compound radicles, one of which, that of tetramethyl ammonium, has properties more typically metallic than has ammonium amalgam.

Tetramethyl ammonium amalgam is readily obtained by the electrolysis of an absolute alcohol solution of tetra-methyl ammonium chloride at 0°. Unlike ammonium amalgam, the new organic metal does not have any tendency to puff up; at 0° to 20°, it is a crystalline solid of characteristic metallic luster. If dry, it is stable at −80°; but decomposes at the rate of about five per cent. a minute at 20°. It reacts violently with liquid water, giving a variety of products and in addition colloidal mercury. When exposed to air at room temperature, it reacts with the moisture and becomes covered with a white coating of tetramethyl ammonium hydroxide—a reaction completely analogous to that shown by sodium amalgam. It precipitates metallic copper from an alcoholic solution of cupric nitrate and metallic zinc from an alcoholic solution of anhydrous zinc chloride.

The single potential difference between the amalgam and a semi-normal solution of the chloride at 0° is nearly two volts. This remains nearly constant for many minutes; thus, in one case, the potential dropped gradually from 1.92 volts to 1.87 volts in thirty-eight minutes. Other complex amalgams have been studied, but none is as stable as tetramethyl ammonium amalgam. We suggest that metallic properties depend on the ability of the atom *or radicle* to lose one or more electrons. Metals may be compounds.

The Zinc Antimony Alloys: B. E. CURRY.

The equilibrium diagram is presented showing the phases to be pure zinc, pure antimony, the compound ZnSb, and three series of solid solutions, α, β and γ.

Corrosion of Cadmium in Nitrate Solutions: G. R. WHITE.

When cadmium is made anode in 75 per cent. sodium nitrate solution and a current of .4 ampere is passed through the corrosion is greater than theoretical. This difference is affected by current density and temperature.

The corrosion produced appeared as a white or grayish precipitate and did not contain metallic cadmium. The solution contained nitrites in large quantities after corrosion began. Analysis indicates the formation of cadmium hydroxid. The formation of nitrites may produce the high corrosion efficiency by the formation of cadmous compounds.

Some Organic Compounds of Beryllium: CHAS. L. PARSONS and GEO. J. SARGENT.

During the last two years Glassman, publishing in the *Berichte*, and Tanatar, publishing in the *Journal of the Russian Physical and Chemical Society*, have claimed to prepare several beryllium salts of organic acids, for which they have claimed definiteness of composition. Glassman announces the dichloracetate, cyanacetate, monochloracetate, monobromacetate, monobrompropionate, lactate, glycolate, trichloracetate, ethylglycolate, phenylglycolate, chloropropionate and salicylate, to which he gives the typical formulas of either $Be_4O(A)_6$ or $Be_3O(A)_4$. Tanatar claims to have prepared the crotonate, isocrotonate, lævulinate and succinate, to which he gives the typical formulas $Be_4O(A)_6$ and the tricarballylate, citrate, salicylate, phthalate, lactate and benzoate, to which he gives somewhat more complex formulas.

These salts were all produced by saturating the aqueous solution of the acid with basic beryllium carbonate and evaporating to dryness, and the formulas were for the main part derived from the simple calculation on the beryllium oxide found, adding water of crystallization when necessary. In one or two instances the lowering of the freezing point in organic solvents was obtained as additional evidence of constitution. For the main part the residues were glassy, gummy masses, although in one or two instances they were thought to be crystalline.

These results were so at variance with previous researches on beryllium compounds where it had been shown that it was next to impossible to obtain definite compounds of such weak acids from aqueous solution that we undertook a careful research in regard to the definiteness of composition of some of these salts and examined more especially the succinate, lactate, glycolate, salicylate, citrate, phthalate, benzoate, picrate and monochloracetate. As a result it was proved without any question that the residues obtained were all of a glassy, glutinous nature and that their composition varied through wide limits according to the extent of the saturation. As one of us has already shown that the salts of beryl-

lium dissolve varying quantities of beryllium carbonate or hydroxide according to the concentration of the acid solutions used, and, further, that the freezing point of solutions containing this material was raised rather than lowered by increasing the quantity of the beryllium hydroxide dissolved, this evidence of constitution is overthrown.

Quite different from these weak acids, however, was the case with the comparatively strong trichloracetate $Be(CCl_3CO_2)_2 2H_2O$, which does yield a perfectly definite compound if prepared, as salts of beryllium of this kind must always be prepared, from solution containing an excess of the acid. This salt was made in several different ways and repeatedly recrystallized, and was shown to have perfect definiteness of composition, losing its two molecules of water of crystallization at 100°. We have no hesitancy in saying that none of the above mentioned acids can be prepared as definite compounds from water solution with the exception of the trichloracetate, and it is probable that this will be found to be true of most acids having a dissociation constant lower than that of trichloracetic acid. Attempts were also made to make definite salts of these acids from solution in organic solvents, but without success.

The Bromates of the Rare Earths—Part II., The Bromates of the Cerium Group and Yttrium: C. JAMES and W. F. LANGELIER.

The pure bromates of lanthanum, cerium, praseodymium, neodymium, samarium and yttrium were prepared from the pure sulphates by treating them with barium bromate and their properties studied.

All of these bromates were found to have the formula $R_2(BrO_3)_6 18H_2O$ and when heated to 100° they were all converted into a hydrate containing $4H_2O$ with the exception of yttrium bromate, whose hydrate at 100° contains $6H_2O$ and cerous bromate. They all lost their water of crystallization and became anhydrous at 150° and at a higher temperature they were all decomposed with evolution of both light and heat. Indeed, praseodymium bromate loses all of its water of crystallization at 130° and decomposes at 150°, while cerous bromate decomposes at a much lower temperature, approximating 50°. In water solution cerous bromate gradually evolves oxygen, precipitating an insoluble residue and leaving behind in solution probably ceric bromate, which, however, was not isolated on account of the ease of its decomposition, its strong aqueous solution being indeed so active an oxidizing agent that it causes explosive combustion of organic material such as filter paper or cotton when poured upon it.

The general results may be summarized as follows:

	Melting Point	100 Parts H_2O Dissolved
$La_2(BrO_3)_6 .18H_2O$	37.5	416
$Ce_2(BrO_3)_6 .18H_2O$	49	—
$Pr_2(BrO_3)_6 .18H_2O$	56.5	190
$Nd_2(BrO_3)_6 .18H_2O$	66.7	146
$Sm_2(BrO_3)_6 .18H_2O$	75	114
$Yt_2(BrO_3)_6 .18H_2O$	74	168

Some Physical Properties of Sulphur Trioxide: D. M. LICHTY, University of Michigan.

Sulphur trioxide, purified by repeated distillation of the commercial article over pure phosphorus pentoxide in a vessel[1] exhausted to 50 mm. or less, melts sharply at 16.8° (Weber 14.8°), boils at a temperature not exceeding 44.8° under 760 mm. pressure, and seems to be purer than that prepared by Weber.[2] If kept from contact with moisture, it retains its sharp melting point and at room temperature is in appearance a very transparent mobile liquid which really consists of a liquid variety, containing, dissolved in it, and presumably in equilibrium with it, a considerable quantity of a solid variety. The depression of the freezing point of phosphorus oxychloride, caused by this mixture, leads to the formula SO_3.[3] The coefficient of expansion is very high, agreeing essentially with that found by Schulz-Sellak[4] and by Schenck.[5] If exposed to a relatively small amount of moist air, the liquid solidifies more or less completely at room temperature. The depression of the freezing point of phosphorus oxychloride, produced by a completely solidified sample, also leads to the formula SO_3. The ordinary asbestos-like needles seem to be a polymer having the formula S_2O_6.[6]

The Modern Manufacture of White Lead: J. S. STANDT.

The paper gives the description and chemistry of the various processes of white-lead manufacture in use, including the Old Dutch, English, French, Milner's, etc. It enumerates some of the more important English and American patents.

[1] *J. Am. Chem. Soc.*, 30, 1836.

[2] *Pogg. Ann.*, 159, 313 (1876).

[3] Oddo, *Gazz. chim. ital.*, 31, II., 158 (1901).

[4] *Ber.*, 3, 215.

[5] *Ann.*, 316, 1 (1901).

[6] Oddo, *loc. cit.*

The paper deals largely with the description and chemistry of the Carter process of white-lead manufacture. By this "quick process" is produced a white lead having the requisite properties of a good paint.

The following papers were reported by title:

The Physical Chemistry of Certain Arrowheads: W. R. Whitney.

The Electrical Conductivity of Concentrated Solutions: E. C. Franklin.

Rapid Electro-analysis with Graphite Cathode Dish: J. W. Turrentine.

Effects of Surfaces on Reactions: F. K. Cameron.

Behavior of the Higher Hydronitrides in Liquid Ammonia: A. W. Browne and T. W. B. Welsh.

Valence—What is it? C. H. Herty.

The Effect of Salts on the Toxicity of Phenol Solutions: W. Lash Miller.

The Formation of Carbon Dioxide in Solutions of Thorium Nitrate: R. B. Moore.

Observations on the Use of the Auxiliary Electrode in Rapid Electrolytic Analysis: E. P. Schoch, Ethel Sykes, D. J. Brown and A. G. Koenig.

The Atomic Weight of Silver: T. W. Richards and H. H. Willard.

Basic Magnesium Chlorides: W. O. Robinson and W. H. Waggaman.

The Relation between Fluidity and Vapor-pressure: E. C. Bingham.

The Tensile Strength of the Zinc-aluminum Alloys: V. J. Skillman.

The Reduction of Nitrobenzene by Iron: R. C. Snowdon.

The Behavior of the Iron Anode in Various Electrolytes: E. P. Schoch and C. P. Randolph.

The Chemical Properties of the Radioactive Products of Thorium: H. N. McCoy.

A New Apparatus for Regulating the Supply of Heating Mediums for Scientific and Similar Apparatus: Geo. E. Edelen.

The Size of Pores in Membranes and Osmotic Effects: S. Lawrence Bigelow.

Lead Silicates: H. C. Cooper.

The Melting Point and Volatility of Chromium: W. C. Arsem and Harold Rush.

Electric Vacuum Furnace Installations in the Research Laboratory of the General Electric Company: W. C. Arsem.

The Salts of Dichlor-tungstic Acid: W. C. Arsem.

Oxalo-molybdic Acid and its Salts: W. C. Arsem.

Molecular Attraction: J. E. Mills.

The Internal Heat of Vaporization: J. E. Mills.

On the Kinetics of Certain Inorganic Reactions in Heterogeneous Media: M. A. Rosanoff and B. S. Merigold.

DIVISION OF ORGANIC CHEMISTS

R. S. Curtiss, chairman

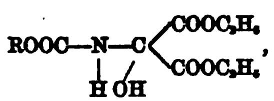
Ralph H. McKee, secretary

Condensations in the Mesoxalic Ester Series: R. S. Curtiss.

Condensations with oxomalonic esters and some alcohols, amines, acidamids and haloid acids have been tried with a view of forming intermediate addition products on the carbonyl group of the ester, also of studying the relative effect of groups of different degrees of positivity or negativity upon the reactivity of the ammonia radical with the carbonyl group of the ester, and the stability of the resulting addition products. Comparative studies of these reactions with methyl and ethyl oxomalonate have been made. Perfectly pure ethyl oxomalonate has been made by distilling the hydrate over P_2O_5.

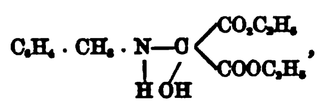
Ethyl, methyl, benzyl and propyl alcohols react with ethyl oxomalonate—with the characteristic loss of color of the keto ester, and formation of thick colorless syrups—which partially dissociate on being heated into the original constituents, and which are changed by water into alcohol and the dihydroxyester.

Ethylurethane forms a crystalline addition product,

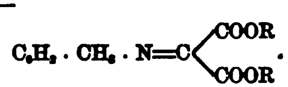


which is transformed into a faintly colored oil by P_2O_5. Urea reacts to give a colorless crystalline product also.

Aniline (1 mol.) reacts with ethyl oxomalonate to give ethyl dianilinomalonate. Attempts to get the intermediate addition body failed. However, *p*-toluidine gives a white crystalline addition compound,



which easily loses H_2O over sulphuric acid—yielding an oil—



This is in analogy with the action of aniline in methyl oxomalonate, which gives a colorless crystal body.

$$C_6H_5—N(H)—C(OH)\left\langle{CO_2CH_3 \atop CO_2CH_3}\right. ,$$

which by P_2O_5 is converted into an oil,

$$C_6H_5N{=}C\left\langle{CO_2CH_3 \atop CO_2CH_3}\right. .$$

This methyl phenyliminomalonate is a remarkable reaction substance, an analogue of phenyl isocyanate. The reactions of this, and analogous compounds in this series, are being investigated.

HCl and HBr appear to add on the carbonyl group of ethyl oxomalonate, but owing to the low temperature (below $-30°$) at which the crystalline products dissociate we have not been able to get true analytical figures as we have done with methyl oxomalonate and these acids, where one molecule of the acid is added to the keto ester.

Hydrogen Polysulphide as a Reducing Agent: ALFRED TINGLE.

The hydrogen polysulphide, or mixture of polysulphides, prepared by boiling lime with flowers of sulphur and acidifying the resulting cooled, clear liquid, possesses the following advantages as a reducing agent. It is neutral; it is readily soluble in ionizing media, such as water or alcohol, and also in non-ionizing liquids, such as carbon disulphide. The exact concentration of these solutions may be determined easily and with a high degree of accuracy by titration with iodine solution. Preliminary experiments on the reducing power of the polysulphide show that its reaction with nitrobenzene is vigorous, but rather complicated. Picric acid is easily reduced, at the ordinary temperature, to picramic acid. The work is being continued at the McMaster University.

Intramolecular Rearrangement of Phthalamidic Acids: J. BISHOP TINGLE and B. F. PARLETT BRENTON.

In continuation of the work of Bishop Tingle and Rolker[7] on the interaction of amines and phthalamidic acids, $RR'NCOC_6H_4CO_2H$, the authors have studied the action of pyridine, aniline and β-naphthylamine, respectively, on phthaldiphenylamidic, phthal-*p*-chlorphenylamidic and phthaldiisobutylamidic acids. An investigation has been made of the behavior of benzylamine with phthal-*p*-tolylamidic and with phthal-*m*-nitrophenylamidic acids; this latter acid has also been caused to react with the following additional bases: alcoholic ammonia, diisoamylamine, benzylethylamine, dibenzylamine, isoamylamine, butylamine, isobutylamine and tribenzylamine. The results are in general accord with the conclusions reached by Bishop Tingle and Rolker. Considering, for the sake of illustration, primary amines, RNH_2, and monosubstituted phthalamidic acids, $RNHCOC_6H_4CO_2H$, one or more of the following four products are formed:

$$C_6H_4\left\langle{CO \atop CO}\right\rangle NR, \quad C_6H_4\left\langle{CO \atop CO}\right\rangle NR',$$

$$RNHCOC_6H_4CONHR' \quad \text{and} \quad C_6H_4(CONHR)_2.$$

Action of Amines on Dicarboxylic Acids of the Aliphatic and Aromatic Series: J. BISHOP TINGLE and B. F. PARLETT BRENTON.

The work of Bishop Tingle with Messrs. Rolker and Brenton (cf. preceding abstract) has shown that, under certain conditions, the chief product of the interaction of amines, RNH_2, on phthalamidic acids, $R'NHCOC_6H_4CO_2H$, is an imide,

$$C_6H_4\left\langle{CO \atop CO}\right\rangle NR' \quad \text{or} \quad C_6H_4\left\langle{CO \atop CO}\right\rangle NR.$$

Occasionally, however, the unsymmetrical or the symmetrical diamide, $R'NHCOC_6H_4CONHR$, or $C_6H_4(CONHR')_2$, is also formed. Bishop Tingle and Bates (cf. following abstract) have found that, under suitable conditions, the diamide is the chief material from amines and dicarboxylic acids of the aliphatic series. Few if any of the unsymmetrical diamides are known. A study has been made, therefore, of the action of a variety of amines on phthalic acid, in the hope that, by selection of suitable experimental conditions and also of the groups R and R″ in the amine, RR″NH (R and R″ = hydrogen, alkyl, or aryl), a method might be developed for the preparation of unsymmetrical amides. The authors have obtained several of the compounds in question and have prepared, in the course of the work, a considerable number of new substances of other types which will be described in due course.

Aliphatic Phenylamidic (Anilic) Acids: J. BISHOP TINGLE and S. J. BATES.

It has been shown by Bishop Tingle and his co-workers that certain amidic acids of the phthalic series, $RNHCOC_6H_4CO_2H$, form salts with amines and that these salts quickly undergo condensation to the imide,

$$C_6H_4\left\langle{CO \atop CO}\right\rangle NR.$$

[7] *J. Am. Chem. Soc.*, 30, 1882.

Similar experiments have been carried out with the following aliphatic amidic acids: furmaranilic, maleanilic, malanilic, tartranilic and oxanilic, but in no case could a similar transformation into the substituted imide be detected. Analogous results were obtained by Bishop Tingle and Lovelace for succinanilic acid.[8] It appears, therefore, that this capacity for intramolecular condensation is a specific property of aromatic acids. The chief products from the aliphatic acids appear to be symmetrical or unsymmetrical diamides, RNHCO ... CONHR, and RNHCO ... CONHR′, respectively. In the course of the work there has been prepared a considerable number of hitherto unknown salts and other derivatives of amines and of the acids mentioned above. These will be described later. In the case of the unsaturated acids the amines form additive compounds with great ease. The addition of the elements of the amine, H and NHR, takes place at the position of the double linkage. Experiments have also been made on the interaction of aniline and some acids of the itaconic series.

Action of Nitranilines on Certain Organic Acids: J. Bishop Tingle and C. E. Burke.

In connection with the investigations of Bishop Tingle and Blanck on the nitration of *N*-acyl derivatives of aniline,[9] a study is being made of the action of the isomeric nitranilines on certain aliphatic and aromatic carboxylic acids. In addition to a number of salts which have not hitherto been described, the authors have prepared several new isomeric nitrophenylamidic (nitranilic) acids, $O_2NC_6H_4NHCO \cdots CO_2H$; nitrophenylamides (nitranilides), $O_2NC_6H_4NHCO \cdots CONHC_6H_4NO_2$ and $O_2NC_6H_4NHCO \cdots CONHR$, and nitrophenylimides (nitranils),

$$\left.\begin{matrix}-CO\\-CO\end{matrix}\right\rangle NC_6H_4NO_2.$$

The results of the investigation promise to furnish some interesting data concerning the relationship between the structure of the nitranilines and the mode of their reactivity in this connection.

The following papers were reported by title:

A Study of Hydrazino Compounds: Wm. McPherson and Howard J. Lucas.

A General Method for Preparing the Pure Sulphates of Hydroxyazo Compounds: William McPherson and Cecil Boord.

Preparation and Oxidation of m-Nitrobenzoylformaldehyde: Wm. L. Evans and E. J. Witzemann.

On Some Amino and Nitroamino Derivatives of Benzoic, Metatoluic and Metaphthalic Acids: M. T. Bogert and A. H. Kropff.

On 2-methyl-3-amino-4-quinazolone and Certain of its Derivatives: M. T. Bogert and R. A. Gortner.

On Oxalylanthranilic Compounds and Some Quinazolines Derived therefrom: M. T. Bogert and R. A. Gortner.

Stereoisomeric Nitrogen Derivatives—Chlorimidoketones: Julius Stieglitz.

The Isolation of Some Further Organic Substances from Soil Humus: (1) *Alpha-hydroxystearic Acid,* (2) *Paraffinic Acid,* (3) *Liquid Fatty Acids:* Oswald Schreiner and Edmund C. Shorey.

The Action of Molecular Silver and Silver Sulphate on Ortho-brominated Triphenylcarbinolchlorides: M. Gomberg and L. L. Van Slyke.

The Constitution of the Double Salts of Triphenylcarbinolhalides with Metal Halides: M. Gomberg and L. P. Kyriakides.

Glycogen Content of Beef Flesh: P. F. Trowbridge and C. K. Francis.

The Barium Salts of Phthalic Acid: F. B. Allan.

A Third Methyl Ester of Phthalic Acid: F. B. Allan and C. G. Allin.

The Preparation and Properties of Phthalyl Cyanide: F. B. Allan and C. H. Robinson.

The Rearrangement of Tautomeric Salts: Sidney Niedlinger.

Researches on Quinazolines (24th paper). *On 6-methyl-7-aminoquinazolones, 7-nitroquinazolone-6 carboxylic acids, and 1, 3, 7, 9-naphthotetrazines:* M. T. Bogert and A. H. Kropff.

Simple χ-β Diglycerides: R. R. Renshaw.

Choline, I.: R. R. Renshaw.

Bactericidal Properties of Lecithin: R. R. Renshaw and K. N. Atkins.

Investigation of the Fruit of the Rose: Nicholas Knight and Layton Gouldin.

Molecular Rearrangements in the Camphor Series: W. A. Noyes, E. Gorsline and Luther Knight.

Some Effects of Solvents containing Hydroxy Groups on True Nitroso Compounds: Edward Kremers.

A New Synthesis of Alkyl Halides: W. C. Arsem.

The Octanes: Nathan Clarke.

B. E. Curry,
Press Secretary

[8] *Am. Chem. J.*, 38, 642.

[9] *J. Amer. Chem. Soc.*, 30, 1395, 1587.

SCIENCE

FRIDAY, SEPTEMBER 10, 1909

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE[1]
ADDRESS OF THE PRESIDENT TO THE GEOLOGICAL SECTION

THE circumstances of the present meeting very clearly determine the subject of a general address to be expected from a student of extinct animals. The remarkable discoveries of fossil backboned animals made on the North American continent during the last fifty years suggest an estimate of the results achieved by the modern systematic methods of research; while the centenary celebration of the birth of Darwin makes it appropriate to consider the extent to which we may begin deducing the laws of organic evolution from the life of past ages as we now know it. Such an address must, of course, be primarily biological in character, and treat of some matters which are not ordinarily discussed by Section C. The subject, however, can only be appreciated fully by those who have some practical acquaintance with the limitations under which geologists pursue their researches, and especially by those who are accustomed to geological modes of thought.

There has been an unfortunate tendency during recent years for the majority of geologists to relinquish the study of fossils in absolute despair. More ample material for examination and more exact methods of research have altered many erroneous names which were originally used; while the admission to scientific publications of too many mere literary exercises on the so-called "law of priority" has now made it necessary to learn not one, but several

[1] Winnipeg, 1909.

names for some of the genera and species which are commonly met with. Even worse, the tentative arrangement of fossils in "genetic series" has led to the invention of a multitude of terms which often serve to give a semblance of scientific exactitude to the purest guess-work, and sometimes degenerate into a jargon which is naturally repellent to an educated mind. Nevertheless, I still hope to show that, with all these difficulties, there is so much of fundamental interest in the new work that it is worth while to make an effort to appreciate it. Geology and paleontology in the past have furnished some of the grandest possible contributions to our knowledge of the world of life; they have revealed hidden meanings which no study of the existing world could even suggest; and they have started lines of inquiry which the student of living animals and plants alone would scarcely have suspected to be profitable. The latest researches are the logical continuation of this pioneer work on a more extensive scale, and with greater precision; and I am convinced that they will continue to be as important a factor in the progress of post-Darwinian biology as were the older studies of fossils in the philosophy of Cuvier, Brongniart and Owen.

In this connection it is necessary to combat the mistaken popular belief that the main object of studying fossils is to discover the "missing links" in the chain of life. We are told that the idea of organic evolution is not worthy of serious consideration until these links, precise in character, are forthcoming in all directions. Moreover the critics who express this opinion are not satisfied to consider the simplest cases, such as are afforded by some of the lower grades of "shell-fish" which live together in immense numbers and have limited power of locomotion. They demand long series of exact links between the most complex skeletal frames of the backboned animals, which have extreme powers of locomotion, are continually wandering, and are rarely preserved as complete individuals when they are buried in rock. They even expect continual discoveries of links among the rarest of all fossils, those of the higher apes and man. The geologist, on the other hand, knowing well that he must remain satisfied with a knowledge of a few scattered episodes in the history of life which are always revealed by the merest accident, marvels that the discovery of "missing links" is so constant a feature of his work. He is convinced that, if circumstances were more favorable, he would be able to satisfy the demand of the most exacting critic. He has found enough continuous series among the mollusca, for example, and so many suggestions of equally gradual series among the higher animals, that he does not hesitate to believe without further evidence in a process of descent with modification. The mere reader of books is often misled by the vagaries of nomenclature to suppose that the intervals between the links are greater than in reality; but for the actual student it is an every-day experience to find that fossils of slightly different ages which he once thought distinct are linked together by a series of forms in which it is difficult to discover the feeblest lines of demarcation. He is therefore justified in proceeding on the assumption that in all cases the life of one geological period has passed by a natural process of descent into that of the next succeeding period; and, avoiding genealogical guesswork which proves to be more and more futile, he strives to obtain a broad view of the series of changes which have occurred, to distinguish between those which denote progress and those which lead to stagnation or extinction. When the general features of organic evolution are determined in this manner, it

will be much easier than it is at present to decide where missing links in any particular case are most likely to be found.

Among these general features which have been made clear by the latest systematic researches, I wish especially to emphasize the interest and significance of the persistent progress of life to a higher plane, which we observe during the successive geological periods. For I think paleontologists are now generally agreed that there is some principle underlying this progress much more fundamental than chance-variation or response to environment, however much these phenomena may have contributed to certain minor adaptations. Consider the case of the backboned animals, for instance, which I happen to have had special opportunities of studying.

We are not likely ever to discover the actual ancestors of animals on the backboned plan, because they do not seem to have acquired any hard skeleton until the latter part of the Silurian period, when fossils prove them to have been typical and fully developed, though low in the backboned scale. The ingenious researches and reasoning of Dr. W. H. Gaskell, however, have suggested the possibility that these animals originated from some early relatives of the scorpions and crustaceans. It is therefore of great interest to observe that the Eurypterids and their allies, which occupy this zoological position, were most abundant during the Silurian period, were represented by species of the largest size immediately afterwards at the beginning of the Devonian, and then gradually dwindled into insignificance. In other words, there was a great outburst of Eurypterid life just at the time when backboned animals arose; and if some of the former were actually transformed into the latter, the phenomenon took place when their powers both of variation and of multiplication were at their maximum.

Fishes were already well established and distributed over perhaps the greater part of the northern hemisphere at the beginning of Devonian times; and then there began suddenly a remarkable impulse towards the production of lung-breathers, which is noticeable not only in Europe and North America, but also probably so far away as Australia. In the middle and latter part of the Devonian period, most of the true fishes had paddles, making them crawlers as much as swimmers; many of them differed from typical fishes, while agreeing with lung-breathers, in having the basis of the upper jaw fused with the skull, not suspended; and some of them exhibited both these features. Their few survivors at the present day (the Crossopterygians and Dipnoans) have also an air-bladder, which might readily become a lung. The characteristic fish-fauna of the Devonian period, therefore, made a nearer approach to the land animals than any group of fishes of later date; and it is noteworthy that in the Lower Carboniferous of Scotland—perhaps even in the Upper Devonian of North America, if footprints can be trusted—amphibians first appeared. In Upper Carboniferous times they became firmly established, and between that period and the Trias they seem to have spread all over the world; their remains having been found, indeed, in Europe, Spitzbergen, India, South Africa, North and South America and Australia.

The Stegocephala or Labyrinthodonts, as these primitive amphibians are termed, were therefore a vigorous race; but the marsh-dwelling habits of the majority did not allow of much variation from the salamander-pattern. Only in Upper Carboniferous and Lower Permian times did some of their smaller representatives (the Microsauria) become lizard-like, or even snake-like, in form and habit; and then there suddenly arose the true reptiles. Still,

these reptiles did not immediately replace the Stegocephala in the economy of nature; they remained quite secondary in importance at least until the Upper Permian, in most parts even until the dawn of the Triassic period. Then they began their flourishing career.

At this time the reptiles rapidly diverged in two directions. Some of them were almost exactly like the little *Sphenodon*, which still survives in some islands off New Zealand, only retaining more traces of their marsh-dwelling ancestors. The majority (the Anomodonts or Theromorphs) very quickly became so closely similar to the mammals that they can only be interpreted as indicating an intense struggle towards the attainment of the higher warm-blooded grade; and there is not much doubt that true mammals actually arose about the end of the Triassic period. Here, again, however, the new race did not immediately replace the old, or exterminate it by unequal competition. Reptiles held their own on all lands throughout the Jurassic and Cretaceous periods, and it was not until the Tertiary that mammals began to predominate.

As to the beginning of the birds, it can only be said that towards the end of the Triassic period there arose a race of small Dinosaurs of the lightest possible build, exhibiting many features suggestive of the avian skeleton; so it is probable that this higher group also originated from an intensely restless early community of reptiles, in which all the variations were more or less in the right direction for advancement.

In short, it is evident that the progress of the backboned land animals during the successive periods of geological time has not been uniform and gradual, but has proceeded in a rhythmic manner. There have been alternations of restless episodes which meant real advance, with periods of comparative stability, during which the predominant animals merely varied in response to their surroundings, or degenerated, or gradually grew to a large size. There was no transition, for instance, between the reptiles of the Cretaceous period and the mammals which immediately took their place in the succeeding Eocene period; those mammals, as we have seen, had actually originated long ages before, and had remained practically dormant in some region which we have not yet discovered, waiting to burst forth in due time. During this retirement of the higher race the reptiles themselves had enjoyed an extraordinary development and adaptation to every possible mode of life in nearly all parts of the globe. We do not understand the phenomenon—we can not explain it; but it is as noticeable in the geological history of fishes as in that of the land animals just considered. It seems to have been first clearly observed by the distinguished American naturalist, the late Professor Edward D. Cope, who termed the sudden fundamental advances "expression points" and saw in them a manifestation of some inscrutable inherent "bathmic force."

Perhaps the most striking feature to be noticed in each of these "expression points" is the definite establishment of some important structural character which had been imperfect or variable before, thus affording new and multiplied possibilities of adaptation to different modes of life. In the first lung-breathers (Stegocephala), for example, the indefinite paddle of the mud fishes became the definite five-toed limb; while the incomplete backbone reached completeness. Still these animals must have been confined almost entirely to marshes, and they seem to have been all carnivorous. In the next grade, that of the reptiles, it became possible to leave the marshes; and some of them were soon adapted not only for life on hard ground or in forests, but even for flight in the air.

Several also assumed a shape of body and limbs enabling them to live in the open sea. Nearly all were carnivorous at first, and most of them remained so to the end; but many of the Dinosaurs eventually became practically hoofed animals, with a sharp beak for cropping herbage, and with powerful grinding teeth. In none of these animals, however, were the toes reduced to less than three in number, and in none of them were the basal toe-bones fused together as they are in cattle and deer. It is also noteworthy that the brain in all of them remained very small and simple. In the final grade of backboned life, that of the mammals, each of the adaptive modifications just mentioned began to arise again in a more nearly perfected manner, and now survival depended not so much on an effective body as on a developing brain. The mammals began as little carnivorous or mixed-feeding animals with a small brain and five toes, and during the Tertiary period they gradually differentiated into the several familiar groups as we now know them, eventually culminating in man.

The demonstration by fossils that many animals of the same general shape and habit have originated two or three times, at two or three successive periods, from two or three continually higher grades of life, is very interesting. To have proved, for example, that flying reptiles did not pass into birds or bats, that hoofed Dinosaurs did not change into hoofed mammals, and that Ichthyosaurs did not become porpoises; and to have shown that all these later animals were mere mimics of their predecessors, originating independently from a higher yet generalized stock, is a remarkable achievement. Still more significant, however, is the discovery that towards the end of their career through geological time totally different races of animals repeatedly exhibit certain peculiar features, which can only be described as infallible marks of old age.

The growth to a relatively large size is one of these marks, as we observe in the giant Pterodactyls of the Cretaceous period, the colossal Dinosaurs of the Upper Jurassic and Cretaceous, and the large mammals of the Pleistocene and the present day. It is not, of course, all the members of a race that increase in size; some remain small until the end, and they generally survive long after the others are extinct; but it is nevertheless a common rule that the prosperous and typical representatives are successively larger and larger, as we see them in the familiar cases of the horses and elephants of the northern hemisphere, and the hoofed animals and armadillos of South America.

Another frequent mark of old age in races was first discussed and clearly pointed out by the late Professor C. E. Beecher, of Yale. It is the tendency in all animals with skeletons to produce a superfluity of dead matter, which accumulates in the form of spines or bosses as soon as the race they represent has reached its prime and begins to be on the down-grade. Among familiar instances may be mentioned the curiously spiny Graptolites at the end of the Silurian period, the horned Pariasaurians at the beginning of the Trias, the armor-plated and horned Dinosaurs at the end of the Cretaceous, and the cattle or deer of modern Tertiary times. The latter case—that of the deer—is specially interesting, because fossils reveal practically all the stages in the gradual development of the horns or antlers, from the hornless condition of the Oligocene species, through the simply forked small antlers of the Miocene species, to the largest and most complex of all antlers seen in *Cervus sedgwicki* from the Upper Pliocene and the Irish deer (*C. giganteus*) of still later times. The growth of these excrescences, both in relative size

and complication, was continual and persistent until the climax was reached and the extreme forms died out. At the same time, although the paleontologist must regard this as a natural and normal phenomenon not directly correlated with the habits of the race of animals in which it occurs, and although he does not agree with the oft-repeated statement that deer may have "perfected" their antlers through the survival of those individuals which could fight most effectively, there may nevertheless be some truth in the idea that the growths originally began where the head was subject to irritating impacts and that they so happened to become of utility. Fossils merely prove that such skeletal outgrowths appear over and over again in the prime and approaching old age of races; they can suggest no reason for the particular positions and shapes these outgrowths assume in each species of animal.

It appears, indeed, that when some part of an animal (whether an excrescence or a normal structure) began to grow relatively large in successive generations during geological time, it often acquired some mysterious impetus by which it continued to increase long after it had reached the serviceable limit. The unwieldy antlers of the extinct Sedgwick's deer and Irish deer just mentioned, for example, must have been impediments rather than useful weapons. The excessive enlargement of the upper canine teeth in the so-called saber-toothed tigers (*Machærodus* and its allies) must also eventually have hindered rather than aided the capture and eating of prey. The curious gradual elongation of the face in the Oligocene and Miocene mastodons, which has lately been described by Dr. Andrews, can only be regarded as another illustration of the same phenomenon. In successive generations of these animals the limbs seem to have grown continually longer, while the neck remained short, so that the head necessarily became more and more elongated to crop the vegetation on the ground. A limit of mechanical inefficiency was eventually reached, and then there survived only those members of the group in which the attenuated mandible became shortened up, leaving the modified face to act as a "proboscis." The elephants thus arose as a kind of afterthought from a group of quadrupeds that were rapidly approaching their doom.

The end of real progress in a developing race of backboned animals is also often marked by the loss of the teeth. A regular and complete set of teeth is always present at the commencement, but it frequently begins to lack successors in animals which have reached the limit of their evolution, and then it soon disappears. Tortoises, for instance, have been toothless since the Triassic period, when they had assumed all their essential features; and birds have been toothless since the end of Cretaceous times. The monotreme mammals of Australasia, which are really a survival from the Jurassic period, are also toothless. Some of the latest Ichthyosaurs and Pterodactyls were almost or quite toothless; and I have seen a jaw of an Upper Cretaceous carnivorous Dinosaur (*Genyodectes*) from Patagonia so completely destitute of successional teeth that it seems likely some of these land reptiles nearly arrived at the same condition.

Among fishes there is often observable still another sign of racial old age—namely, their degeneration into eel-shaped forms. The Dipnoan fishes afford a striking illustration, beginning with the normally shaped *Dipterus* in the Middle Devonian, and ending in the long-bodied *Lepidosiren* and *Protopterus* of the present day. The Paleozoic Acanthodian sharks, as they are traced upwards from their beginning in the Lower Devonian to their end in the Permian, also acquire a remark-

able elongation of the body and a fringe-like extension of the fins. Among higher fishes, too, there are numerous instances of the same phenomenon, but in most of these the ancestors still remain undiscovered, and it would thus be tedious to discuss them.

Finally, in connection with these obvious symptoms of old age in races, it is interesting to refer to a few strange cases of the rapid disappearance of whole orders of animals, which had a practically world-wide distribution at the time when the end came. Local extinction, or the disappearance of a group of restricted geographical range, may be explained by accidents of many kinds; but contemporaneous universal extinction of widely spread groups, which are apparently not affected by any new competitors, is not so easily understood. The Dinosaurs, for instance, are known to have lived in nearly all lands until the close of the Cretaceous period; and, except perhaps in Patagonia, they were always accompanied until the end by a typically Mesozoic fauna. Their remains are abundant in the Wealden formation of western Europe, the deposit of a river which must have drained a great continent at the beginning of the Cretaceous period; they have also been found in a corresponding formation which covers a large area in the state of Bahia, in Brazil. They occur in great numbers in the fresh-water Upper Cretaceous Laramie deposits of western North America, and also in a similar formation of equally late date in Transylvania, southeast Europe. In only two of these regions (southeast England and west North America) have any traces of mammals been found, and they are extremely rare fragments of animals as small as rats; so there is no reason to suppose that the Dinosaurs suffered in the least from any struggle with warm-blooded competitors. Even in Patagonia, where the associated mammal-remains belong to slightly larger and more modern animals, these fossils are also rare, and there is nothing to suggest competition. The race of Dinosaurs seems, therefore, to have died a natural death. The same may be said of the marine reptiles of the orders Ichthyosauria, Plesiosauria and Mosasauria. They had a practically world-wide distribution in the seas of the Cretaceous period, and the Mosasauria especially must have been extremely abundant and flourishing. Nevertheless, at the end of Cretaceous times they disappeared everywhere, and there was absolutely nothing to take their place until the latter part of the Eocene period, when whales and porpoises began to play exactly the same part. So far as we know, the higher race never even came in contact with the lower race; the marine mammals found the seas vacant, except for a few turtles and for one curious Rhynchocephalian reptile (*Champsosaurus*), which did not long survive. Another illustration of the same phenomenon is probably afforded by the primitive Carnivora (the so-called Sparassodonta), which were numerous in South America in the Lower Tertiary periods. They were animals with a brain as small as that of the thylacines and dasyures which now live in Tasmania. They appear to have died out completely before they were replaced by the cats, saber-toothed tigers and dogs, which came down south from North America over the newly emerged Isthmus of Panama at the close of the Pliocene period. At least, the remains of these old carnivores and their immigrant successors have never yet been found associated in any geological formation.

These various considerations lead me to think that there is also deep significance in the tendency towards fixity in the number and regularity (or symmetry) in the arrangement of their multiple parts, which we frequently observe in groups of animals

as we trace them from their origin to their prime. It is well known that in certain of the highest and latest types of bony fishes the vertebræ and fin-rays are reduced to a fixed and practically invariable number for each family or genus, whereas there is no such fixity in the lower and earlier groups. In the earliest known Pycnodont fishes from the Lower Lias (*Mesodon*) the grinding teeth form an irregular cluster, while in most of the higher and later genera they are arranged in definite regular rows in a symmetrical manner. Many of the lower backboned animals have teeth with several cusps, and in some genera the number of teeth seems to be constant; but in the geological history of the successive classes the tooth-cusps never became fixed individual entities, readily traceable throughout whole groups, until the highest or mammalian grade had been attained. Moreover, it is only in the same latest grade or class that the teeth themselves can be treated as definite units, always the same in number (forty-four), except when modified by degeneration or special adaptation. In the earlier and lower land animals the number of vertebræ in the neck depends on the extent of this part, whereas in the mammal it is almost invariably seven, whatever the total length may be. Curiously constant, too, in the modern even-toed hoofed mammals is the number of nineteen vertebræ between the neck and the sacrum.

I am therefore still inclined to believe that the comparison of vital processes with certain purely physical phenomena is not altogether fanciful. Changes towards advancement and fixity which are so determinate in direction, and changes towards extinction which are so continually repeated, seem to denote some inherent property in living things, which is as definite as that of crystallization in inorganic substances. The regular course of these changes is merely hindered and modified by a succession of checks from the environment and natural selection. Each separate chain of life, indeed, bears a striking resemblance to a crystal of some inorganic substance which has been disturbed by impurities during its growth, and has thus been fashioned with unequal faces, or even turned partly into a mere concretion. In the case of a crystal the inherent forces act solely on molecules of the crystalline substance itself, collecting them and striving, even in a disturbing environment, to arrange them in a fixed geometrical shape. In the case of a chain of life (or organic phylum) we may regard each successive animal as a temporary excrescence of colloid substance round the equally colloid germ-plasm which persists continuously from generation to generation. The inherent forces of this germ-plasm, therefore, act upon a consecutive series of excrescences (or animal bodies), struggling not for geometrically arranged boundaries, but towards various other symmetries, and a fixity in number of multiple parts. When the extreme has been reached, activities cease, and sooner or later the race is dead.

Such are some of the most important general results to which the study of fossils has led during recent years; and they are conclusions which every new discovery appears to make more certain. When we turn to details, however, it must be admitted that modern systematic researches are continually complicating rather than simplifying the problems we have to solve. Professor Charles Depéret has lately written with scant respect of some of the pioneers who were content with generalities, and based their conclusions on the geological succession of certain anatomical structures rather than on a successive series of individuals and species obtained from the different layers of one geological section; but even now I do not think we can do much

better than our predecessors in unraveling real genealogies. At least Professor Depéret's genealogical table of the Lower Tertiary pig-like Anthracotheriidæ, which he publishes as an illustration of "évolution réelle," seems to me to be no more exact than several tables of other groups by previous authors which he criticizes. His materials are all fragmentary, chiefly jaws and portions of skulls; they were obtained from several isolated lake-deposits, of which the relative age can not be determined by observing the geological superposition; and they represent a group which is known to have lived over a large part of Europe, Asia, northern Africa and North America. There is therefore no certainty that the genera and species enumerated by Professor Depéret actually originated one from the other in the region where he happened to find them; he has demonstrated the general trend of certain changes in the Anthracotheriidæ during geological time, but really nothing more.

Even when a group of animals seems to to have been confined to one comparatively small region, where the series is not complicated by migration to and from other parts of the world, modern research still emphasizes the difficulty of tracing real lines of descent. The primitive horned hoofed animals of the family Titanotheriidæ, for example, are only known from part of North America, and they seem to have originated and remained there until the end. As their fossil skeletons are abundant and well preserved, it ought to be easy to discover the exact connections of the several genera and species. Professor Osborn has now proved, however, that the Titanotheres must have evolved in at least four distinct lines, adapted "for different local habitat, different modes of feeding, fighting, locomotion, etc., which took origin, in part at least, in the Middle or Upper Eocene." They exhibit "four distinct types in the shape and position of the horns, correlated with the structure of the nasals and frontals, and indicative of different modes of combat among the males." The ramifications of the group are indeed so numerous that the possibility of following chains of ancestors begins to appear nearly hopeless.

Among early reptiles the same difficulties are continually multiplied by the progress of discovery. About twenty years ago it began to appear likely that we should soon find the terrestrial ancestors of the Ichthyosauria in the Trias; and somewhat later a specimen from California raised hopes of obtaining them by systematic explorations in that region. During more recent years Professor J. C. Merriam and his colleagues have actually made these explorations, and the result is that we now know from the Californian Trias a multitude of reptiles, which need more explanation than the Ichthyosauria themselves. Professor Merriam has found some of the links predicted between Ichthyosaurs and primitive land reptiles, but he has by no means reached the beginning of the marine group; and while making these discoveries he has added greatly to the complication of the problem which he set out to solve.

Serious difficulties have also become apparent during recent years in determining exactly the origin of the mammals. For a long time after the discovery of the Anomodont or Theromorph reptiles in the Permian-Trias of South Africa, it seemed more and more probable that the mammals arose in that region. Even yet new reptiles from the Karoo formation are continually being described as making an astonishingly near approach to mammals; and, so far as the skeleton is concerned, the links between the two grades are now very numerous among South African fossils. Since these reptiles first attracted attention, however, they have gradually been

found in the Permian and Trias of a large part of the world. Remains of them were first met with in India, then in North America, and next in Scotland, while during the last few years Professor W. Amalitzky has disinterred so many nearly complete skeletons in the north of Russia that we are likely soon to learn more about them from this European country than from the South African area itself. Quite lately I have received numerous bones from a red marl in Rio Grande do Sul, southern Brazil, which show that not merely Anomodonts, but also other characteristic Triassic land reptiles, were likewise abundant in that region. We are therefore now embarrassed by the richness of the sources whence we may obtain the ancestors of mammals. Whereas some years ago it appeared sufficient to search South Africa for the solution of the problem, we are now uncertain in which direction to turn. We are still perhaps inclined to favor the South African source; but this is only because we know nothing of the Jurassic land animals of that part of the world, and we cherish a lingering hope that they may eventually prove to have included the early mammals for which we have so long sought in vain.

The mystery of the origin of the marine mammals of the order Sirenia and Cetacea appears to have been diminished by the discoveries of the Geological Survey of Egypt, Dr. Andrews and Dr. Fraas in the Eocene and Oligocene deposits of the Mokattam Hills and the Fayum. It is now clear that the Sirenians are closely related to the small primitive ancestors of the elephants; while, so far as the skull and dentition are concerned, we know nearly all the links between the early toothed whales (or Zeuglodonts) and the primitive ancestors of the Carnivora (or Creodonts). The most primitive form of Sirenian skull hitherto discovered, however, is not from Egypt, but from the other side of the world, Jamaica; and exactly the same Zeuglodonts, even with an associated sea-snake, occur so far away from Egypt as Alabama, U. S. A. The problem of the precise origin of these marine mammals is therefore not so simple as it would have appeared to be had we known only the Egyptian fossils. The progress of discovery, while revealing many most important generalities, has made it impossible to vouch for the accuracy of the details in any "genealogical tree."

Another difficulty resulting from the latest systematic researches is suggested by the extinct hoofed mammals of South America. The llamas, deer and peccaries existing in South America at the present time are all immigrants from the northern continent; but during the greater part of the Tertiary period there lived in that country a large number of indigenous hoofed mammals, which originated quite independently of those in other regions. They seem to have begun in early Eocene times much in the same manner as those of the northern hemisphere; but as they became gradually adapted for life on hard ground, they formed groups which are very different from those with which we are familiar in our part of the world. Some of them (Proterotheriidæ) were one-toed mimics of the horses, but without the advanced type of brain, the deepened grinding teeth, the mobile neck, or the really effective wrist and ankle. Others (Toxodontidæ) made some approach towards rhinoceroses in shape and habit, even with a trace of a horn on the nose. Until their independent origin was demonstrated, these curious animals could not be understood; and it is probable that there are innumerable similar cases of parallel development of groups, by which in our ignorance we are often misled.

It would be easy to multiply instances, but I think I have now said enough to show

that every advance in the study of fossils reveals more problems than it solves. During the last two decades the progress in our knowledge of the extinct backboned animals has been truly astonishing, thanks especially to the great explorations in North America, Patagonia, Egypt, Madagascar and South Africa. Whole groups have been traced a long way towards their origin; but with them have been found a number of previously unknown groups which complicate all questions of evolution to an almost bewildering extent. Animals formerly known only by fragments are now represented by nearly complete skeletons, and several which appeared to have a restricted geographical range have now been found over a much wider area; but while this progress has been made, numerous questions have arisen as to the changing connections of certain lands and seas which previously seemed to have been almost settled. The outlook both of zoology and of geology has, therefore, been immensely widened, but the only real contribution to philosophy has been one of generalities. Some of the broad principles to which I have referred are now so clearly established that we can often predict what will be the main result of any given exploration, should it be successful in recovering skeletons. We are no longer bold enough to restore an entirely unknown extinct animal from a single bone or tooth, like the trustful Cuvierian school; but there are many kinds of bones and teeth of which we can determine the approximate geological age and probable associates, even if we have no exact knowledge of the animals to which they belong. A subject which began by providing material for wonder-books has thus been reduced to a science sufficiently precise to be of fundamental importance to both zoology and geology; and its exactitude must necessarily increase with greater and greater rapidity as our systematic researches are more clearly guided by the experience we have already gained.

A. Smith Woodward

The British Museum

ENTOMOLOGICAL RESEARCH [1]

In view of the intimate relation which is recognized as existing between certain insects and the propagation of diseases of both man and animals in tropical Africa, and of the similar relation between insects and economic plants, which is becoming more evident as settlement in the continent progresses, Lord Crewe has appointed a scientific committee, whose object it will be to further the study of economic entomology with special reference to Africa.

This body will be known as the African Entomological Research Committee; and Lord Cromer has kindly consented to act as chairman. The other members of the committee are:

Colonel A. Alcock, C.I.E., F.R.S., of the London School of Tropical Medicine.

Mr. E. E. Austen, of the Natural History Museum.

Dr. A. G. Bagshawe, director of the Sleeping Sickness Bureau.

Dr. J. Rose Bradford, F.R.S., secretary of the Royal Society.

Colonel Sir David Bruce, C.B., F.R.S.

Dr. S. F. Harmer, F.R.S., keeper of zoology, British Museum (Natural History).

Dr. R. Stewart MacDougall, entomological adviser to the Board of Agriculture.

Sir John Macfadyean, Royal Veterinary College.

Sir Patrick Manson, K.C.M.G., F.R.S.

Mr. R. Newstead, of the Liverpool School of Tropical Medicine.

Dr. G. F. Nuttall, F.R.S., Quick professor of biology, Cambridge University.

Professor E. B. Poulton, F.R.S., Hope professor of zoology, Oxford.

Lieutenant-Colonel D. Prain, C.I.E., F.R.S., director of the Royal Botanic Gardens, Kew.

Mr. H. J. Read, C.M.G., representing the Colonial Office.

The Hon. N. C. Rothschild.

Dr. D. Sharp, F.R.S.

Dr. A. E. Shipley, F.R.S., Cambridge University.

[1] From the London *Times*.

Mr. S. Stockman, chief veterinary officer to the Board of Agriculture.

Mr. F. V. Theobald, of the Agricultural College, Wye.

Mr. C. Warburton, Cambridge University.

Mr. A. C. C. Parkinson, of the Colonial Office, is acting as secretary to the committee, and Mr. Guy A. K. Marshall as scientific secretary.

Arrangements are now being made to despatch a trained entomologist to the east side of tropical Africa and another to the west, for the purpose of stimulating official and other residents to collect and observe noxious insects, and of affording instruction in the use of scientific methods. By this means it is hoped to obtain throughout these territories an organized body of investigators who will communicate all their collections and observations to the committee. These collections will be classified by a number of British and in some instances continental entomologists, and named specimens will be distributed to such institutions as may require them for purposes of instruction, both at home and in Africa. The committee will also keep in touch with the work which is being done in this branch of science in Egypt and the Sudan and in South Africa. The scientific results, including all observations and experiments made by the collectors, will be published from time to time in a journal or bulletin to be issued by the committee. It is hoped that by such organized cooperation the knowledge of these matters will be materially increased, so as to render possible the application of effective remedial measures. Offers of cordial assistance have been received from such institutions as the British Museum (Natural History), the London and Liverpool Schools of Tropical Medicine and the leading universities, in all of which valuable work has already been done in the same direction.

SECOND INTERNATIONAL CONGRESS FOR THE REPRESSION OF ADULTERATION AND FRAUDS IN FOOD AND DRUGS

THE Second International Congress under the auspices of the White Cross Society will be held in Paris, October 17–24 (inclusive), 1909. The meeting will be held under the patronage of the Minister of Agriculture; the Minister of the Interior, President of the Council; the Minister of Commerce; the Under Secretary of State for the War Department; the President of the Municipal Council of the City of Paris and the President of the General Council of the Department of the Seine, Paris. The president of the congress is Dr. Bordas, director of the laboratories of the Ministry of Finance; the vice-president is Dr. Eug. Roux, Chief of the Service for the Repression of Adulteration, at the Ministry of Agriculture; the general secretary is M. Ch. Franche, 16 Place Vendome, Paris, France, to whom all communications relating to papers should be addressed.

The congress is divided into three sections: First Section, alimentary technology; Second Section, hygiene; Third Section, crude drugs, essential oils and crude aromatic substances, chemical products and mineral waters.

There are three classes of members, first, donating members, those paying 100 francs ($20) are enrolled as such; second, titulary members, any person, society or corporate body having paid twenty francs ($4) is entitled to become a titulary member; third, associate members, any person, belonging to the family of a donor or titulary member, who pays the sum of ten francs ($2) may be an associate member. Associate members do not receive the publications of the congress, nor participate in the voting or debates. They are, however, invited to all official fetes and receptions and are entitled to any rebate for traveling expenses and to attend the sittings of the congress.

Important questions concerning the adulteration and misbranding of food and drugs will be discussed in the congress and actions taken thereon. State Dairy and Food Commissioners, food and drug officials of the various states and municipalities and manufacturers of and dealers in foods and drugs are invited to become members and take an active part in the proceedings of the congress by attendance in person, presentation of papers or otherwise.

Dr. H. W. Wiley has been designated as

representative of the White Cross Society in America and will, on request, send a pamphlet giving full details of the congress to any intending member. He will also undertake to forward to Paris the names of subscribers and their fees, if the same should be sent to him in Washington, D. C. All persons sending their fees directly to Paris are requested to send Dr. Wiley their names in order that he may have a complete list of the American participants.

The congress is held at an opportune time for American members, since the rush of travel eastward is now over, and by the time the congress adjourns the rush of travel westward will be materially lessened. The attending members, therefore, will not have difficulty in securing passage each way.

The president of the Universal Society of the White Cross of Geneva is Professor Dr. Ch. Vuille, Geneva, Switzerland; the general delegate or manager of the society is M. Paul Bolo, Paris, France.

Intending members are urgently requested to send names and fees without delay to Dr. Wiley, also titles and abstracts of papers.

THE TWENTIETH ANNIVERSARY OF CLARK UNIVERSITY

FROM the sixth to the eighteenth of September Clark University will celebrate the completion of the twentieth year of its activity by a series of lectures and discussions in each of the departments of mathematics, physics, chemistry, biology, psychology, pedagogy and history, and several academic and social meetings.

Each department will hold morning, afternoon and evening sessions, as follows:

September 6–11—Psychology and Pedagogy.
" 7– 9—Biology.
" 7–11—Mathematics and Physics.
" 13–18—History.
" 14–17—Chemistry.

There will be two general academic sessions, at which honorary degrees will be conferred, one on the evening of Friday, September tenth, and the other some evening in the following week. The first of these general sessions and probably the second will be followed by a reception.

The program of the departments of psychology and pedagogy have already been referred to in SCIENCE. In the department of biology a series of conferences has been arranged on nature study and the teaching of biology.

In mathematics lectures will be given by Professor E. H. Moore, of the University of Chicago; Professor E. B. Van Vleck, of the University of Wisconsin, and Professor James Pierpont, of Yale University. Dr. Percival Lowell will give an evening lecture on the planet Venus, and there will be during the week an exhibition of drawings and photographs from the Lowell Observatory. There will further be several discussions on pedagogical topics.

In physics, there will be series of lectures by Professor Vito Volterra, of the University of Rome, and lectures by Professor Ernest Rutherford, of the University of Manchester; Professor A. A. Michelson, of the University of Chicago; Professor Carl Barus, of Brown University; President E. F. Nichols, of Dartmouth College, and Professor R. W. Woods, of the Johns Hopkins University. There will also be a series of conferences on the teaching of physics in schools, colleges and universities. Among those who have consented to take part in these conferences are Professors E. H. Hall, Harvard University; Henry Crew, Northwestern University; A. Wilmer Duff, Worcester Polytechnic Institute; William S. Franklin, Lehigh University; M. I. Pupin, Columbia University; William F. Magie, Princeton University; Arthur L. Kimball, Amherst College; A. P. Wills, Columbia University; C. Riborg Mann, University of Chicago, and John F. Woodhull, Teachers College, Columbia University.

In chemistry a very extensive program has been arranged. Among those who will give addresses or make reports are President Ira Remsen, of the Johns Hopkins University; Professor W. A. Noyes, of the University of Illinois; Professor M. T. Bogert, of Columbia University; Professor Arthur Michael, of

Tufts College; Professor Theodore W. Richards, of Harvard University; Professors H. P. Talbot and A. A. Noyes, of the Massachusetts Institute of Technology; Professor Wilder D. Bancroft, of Cornell University; Dr. Willis R. Whitney, president of the American Chemical Society, and M. Debierne, of Paris.

THE NORTH POLE

READERS of SCIENCE will have been greatly interested in the full reports published in the daily papers in regard to Dr. Frederic A. Cook's adventurous expedition. It is not necessary to repeat here the descriptions that have been published, and there is not at hand an account of scientific results. The interest is indeed dramatic and human rather than scientific. A performance such as reaching the North Pole or flying across the British Channel would be rather a result made possible by scientific progress than an important contribution to the advancement of science. But courage and resourcefulness make a deep effect on human nature; scientific men may well be pleased to note the exhibition of such traits on the outskirts of their field.

From a scientific man of the highest rank, who has especial competence to form an opinion on the subject, the editor has received the suggestion that men of standing and representative position be invited to sign the letter that is subjoined. The editor would be pleased to receive from scientific men their opinion as to the desirability of such action, but suggests that it would probably be best for the leading geographical societies of the country to unite in appointing a joint committee to report on the subject. The proposed letter reads:

The statements published in the press relative to the claim of Dr. F. A. Cook that he reached the North Pole on April 21, 1908, have been of such a nature as to awaken, in many minds, skepticism as to the validity of the claim. If it be valid, it is highly important to remove these suspicions as promptly and completely as possible. If it be invalid, it is not less important that American men of science withhold their acceptance of a questionable claim. In view of the fact that the observations and photographs which would be taken by a competent person properly equipped, in the course of a trip to the North Pole, should bear ample evidence of its actuality, we ask you to publish in SCIENCE the following requests:

1. That Dr. F. A. Cook publish as promptly as practicable a full statement of the essential facts with all such data as will bear evidence of the validity of his claim.

2. That, if in your judgment, after conference with men of judicial attitude accessible to you, this statement shall not of itself clear away all reasonable grounds of suspicion, you, as editor of SCIENCE, select a committee of seven persons of critical knowledge in the matters involved and request them to make a critical examination of the data and give the scientific public the benefit of their best judgment.

3. That, meanwhile, all American scientific societies withhold all action relative to the matter, to the end that if the attainment of the North Pole is properly authenticated there may be united action in doing the fullest honor due to Dr. Cook, and that if the claim is not authenticated there be equal unanimity in withholding honor that has not been duly earned.

As the present issue of SCIENCE is going to press, the news is announced of the successful termination of Commander Peary's expedition to the North Pole.

SCIENTIFIC NOTES AND NEWS

MR. PHILIP FOX, hitherto instructor in astrophysics at the Yerkes Observatory, University of Chicago, assumed the duties of professor of astronomy in the Northwestern University and director of the Dearborn Observatory, Evanston, Illinois, on September 1. He is succeeded at the Yerkes Observatory by Dr. Frederick Slocum, for several years assistant professor of astronomy at Brown University, who has just returned from a year in Europe, principally spent at the Royal Astrophysical Observatory at Potsdam.

DRS. F. B. LANEY (Yale, 1908) and J. E. Pogue (Yale, 1909) have been appointed assistant curators in the department of geology of the U. S. National Museum; the former in the division of applied geology and the latter in the division of mineralogy.

DR. E. D. DURAND, the director of the census, has announced the appointment of experts in statistics, economics, agriculture and manufactures to cooperate with him in the formulation of the census schedules on which the enumerators will enter the information they obtain next April. The conferees on the agricultural schedule are: Dr. J. L. Coulter, instructor in agricultural economics in the University of Minnesota; Dr. H. C. Taylor, professor of agricultural economics in the University of Wisconsin; Dr. C. F. Warren, Jr., professor of farm management in Cornell University, and Dr. T. M. Carver, professor of economics in Harvard University. The conferees for manufactures and on population are leading experts, being in most cases university professors.

THE chief examiners in the sciences for the college entrance examination board next year are: in mathematics, Professor R. W. Prentiss, of Rutgers College; in physics, Professor F. A. Waterman, of Smith College; in chemistry, Professor Alexander Smith, of the University of Chicago; in geography, Professor A. P. Brigham, of Colgate University; in zoology, Professor G. H. Parker, of Harvard University, and in botany, Professor W. W. Rowlee, of Cornell University.

PROFESSOR THOMAS C. CHAMBERLIN, of the department of geology of the University of Chicago, and Dr. Rollin T. Chamberlin, have returned from the expedition sent by the University of Chicago to study educational conditions in the orient.

THE University of Chicago paleontological expedition to the Permian of northern Texas has returned from a most successful trip. Numerous skulls and skeletons of small reptiles and amphibians were secured, giving to the University of Chicago, with its previous collections from that formation, an excellent representation of Permian vertebrates.

THE Michigan Biological Survey is, this summer, investigating the fauna and flora of Dickinson County, Michigan. The work is under the direction of Alexander G. Ruthven, the chief field naturalist of the survey, and the members of the party, and the groups to which they are giving primary attention, are as follows: A. G. Ruthven and F. Gaige (vertebrates), H. Baker (molluscs), W. W. Newcomb (insects) and G. H. Coons (botany).

MR. MYRON L. FULLER, who has recently completed his report on the differentiation of the glacial drifts of Long Island, New York, upon which he has been at work for the United States Geological Survey for some years, will sail in October for a trip around the world, the principal stays being made in India and Japan with shorter stops in Java and Borneo.

DR. JUAN GUITARAS has consented to remain director of sanitation and chairman of the National Board of Health for Cuba, in view of the fact that the government has now appropriated sufficient funds for the work of the department of sanitation.

PROFESSOR W. M. KERR, of Oregon, has been elected president of the Association of American Agricultural Colleges and Experiment Stations, at the recent meeting held at Portland, Oregon.

CAPTAIN HERBERT E. PUREY CUST, R.N., assistant hydrographer, has been appointed to be hydrographer of the British Navy in the place of Rear-Admiral Arthur M. Field, F.R.S.

THE permanent commission of the International Association of Seismology was held at Zermatt on August 30 with Professor Arthur Schuster, F.R.S., as chairman. Among the papers on the program was one by Professor Harry Fielding Reid, of the Johns Hopkins University, on "Some Lessons of the California Earthquake."

DR. OTTO VON BOLLINGER, professor of pathology at Munich, has died at the age of sixty-seven years.

DR. KARL FRIEDHEIM, formerly professor of organic chemistry at Berne, has died at the age of fifty-one years.

The monument erected to the memory of Professor Tillaux, of Paris, will be dedicated on October 7, 1909, at the amphitheater of anatomy of the hospitals.

Among the civil service examinations to be held by the state of New York on September 18 is one for inspector of drawing and industrial training at a salary of $2,500 and for assistant sanitary chemist at a salary of from $1,200 to $1,500.

The Imperial Cancer Research Fund has received from the Duke of Bedford, vice-president, a further donation of £1,000.

We learn from *Nature* that at the meeting of the Royal Horticultural Society on August 31, there was an exhibition on behalf of Professor Sargent and Harvard University of photographs illustrating the flora, fauna and scenery of central and western China. The photographs are from the large collection taken by Mr. E. H. Wilson during his last (third) journey to China.

Dr. Charles H. Frazier has resigned the deanship of the medical school of the University of Pennsylvania. He retains his connection with the school as professor of clinical surgery.

Dr. E. A. Erlanger has been appointed associate professor of physiology at the Johns Hopkins University to succeed Dr. Percy M. Dawson, who has resigned to take up the study of theology.

Mr. Lee I. Knight, of the botanical staff of the University of Illinois, has been appointed associate professor of botany at Clemson College, South Carolina.

Mr. Wilmar E. Davis, of the University of Chicago, has been appointed assistant professor of botany at Kansas Agricultural College, Manhattan, Kansas.

Dr. Thomas H. Bryce, lecturer on anatomy at Queen Margaret's College, Glasgow, has been appointed to the chair of anatomy at the University of Glasgow in the place of Professor Cleland.

Dr. Karl Marbe, of the Frankfort Academy, has been called to the chair of philosophy at Würzburg.

The graduates of the courses in chemistry at the University of Wisconsin will hold positions in chemical laboratories all over the country this year, 47 having recently received appointment in 17 different states. Of these 14 will remain in Wisconsin, six being in the university, three in colleges and normals, three in high schools and two in commercial positions. The Bureaus of Soils and of Standards at Washington have appointed five Wisconsin chemists to government positions, while four others go to Missouri. New York, Michigan and Illinois have each given three collegiate or commercial positions to Wisconsin men, while the states of Washington, Pennsylvania, South Dakota and Iowa have appointed two Wisconsin graduates each, and Oregon, Indiana, Arizona, Ohio, California, Oklahoma and Kansas have each a man from the Wisconsin state university chemistry department.

We learn from *Nature* that meetings of two special commissions appointed by the International Meteorological Committee at Paris in 1907 were held in London during the week commencing June 21. The appointment of the first commission arose out of a proposal made at Innsbruck by the Rev. Lowis Froc, S.J., director of the Zi-ka-wei Observatory, for the general adoption of a code of maritime weather signals now in use in far eastern waters, and a further proposal made at Paris by Professor Willis L. Moore, chief of the United States Weather Bureau, in favor of an international system of maritime weather signals. To this commission the question of an understanding as to the projection and scale of charts for representing marine meteorological data was also referred. The second commission is appointed to consider international questions concerning weather telegraphy, including wireless telegraphy from ships. The commissions will report to the meeting of the International Meteorological Committee which is expected to be held in 1910.

Students of American geology and geography owe much to the four great government organizations which worked in the west between 1867 and 1879, before the establishment

of the United States Geological Survey. These organizations are commonly known as the Hayden, King, Powell and Wheeler Surveys, from the men in charge, of whom Clarence King later became the first director of the United States Geological Survey and J. W. Powell the second. The publications of these earlier surveys constitute a storehouse of geographic, geologic, ethnologic and archeologic information concerning the then almost unknown western portion of the United States and though their usefulness may have diminished as a result of more detailed surveys and more precise work, they are still invaluable to all who are interested in the study of the development of the west. The United States Geological Survey has published a catalogue and consolidated index of these publications, by Mr. L. F. Schmeckebier, that will make the information they contain easily accessible. This catalogue can be obtained free on application to the director, U. S. Geological Survey, Washington, D. C.

THE total production of coal in the United States in 1908, as reported by Mr. E. W. Parker, of the United States Geological Survey, was 415,842,698 short tons, having a spot value of $532,314,117. Of this total, 83,268,754 short tons, with a spot value of $158,178,849, was Pennsylvania anthracite and 332,573,944 short tons, with a spot value of $374,135,262, was bituminous and lignite. In 1907, when the maximum output of both anthracite and bituminous coal was recorded, the total production amounted to 480,363,424 short tons, valued at $614,798,898, of which 85,604,312 short tons, valued at $163,584,056, was Pennsylvania anthracite and 394,759,112 short tons, valued at $451,214,842, was bituminous, semibituminous and lignite, with scattered lots of anthracite and semianthracite. The total production in 1908 showed a decrease of 64,520,726 short tons, or 13.43 per cent. in quantity, and of $82,484,781, or 13.42 per cent. in value. In spite of the depressed conditions, the decrease in the production of Pennsylvania anthracite was only 2,335,558 short tons, or 2.73 per cent. in quantity and $5,405,207, or 3.3 per cent. in value. In the production of bituminous coal, the decrease in 1908 amounted to 62,185,168 short tons, or 15.75 per cent. in quantity and to $77,079,574, or 17.08 per cent. in value.

THE next to the largest of the Brenham (Kiowa County, Kansas) siderolites, weighing something over 218 pounds, has lately passed from the Snow estate, into the possession of Dr. F. W. Cragin, of Colorado Springs, Colo. These meteorites belong to the rare and remarkable group known as *pallasites*, named for Pallas, who described the first example of this class, from Medwedewa, Krasnojarsk, Russia, in 1776. They were first identified as pallasites, by Professor Cragin, the original purchaser of the main part of them, in letters to Professor John S. Newberry and others. The first printed descriptions of them were published in SCIENCE of May 9 and July 18, 1890, by Mr. George F. Kunz and Professor F. H. Snow, and were more elaborately studied in Vol. XXI. of the Proceedings of the American Academy of Arts and Sciences, by Dr. O. W. Huntington. A beautiful and characteristic illustration of the structure of these pallasites, is that of a polished section which was published in 1900 by Professor Henry A. Ward, as Plate VI. of his book on the great Ward-Coonley Collection of Meteorites, in Chicago. The fact that a few *siderites*, or plain nickeliferous irons, constituted a part of the same "fall" with the Kiowa County pallasites, was a remarkable circumstance, and led Dr. Huntington to suggest the interesting and plausible theory that the eruption of the heavenly body that yielded the Brenham meteorites, had ejected them from an intermediate or transitional zone, between the deeper, heavier, metallic, or *siderite-yielding* zone (such as the terrestrial one whose existence we may infer from the specific gravity of the earth's whole mass being much greater than that of its outer and known portion) and the more superficial, lighter zone, that would yield meteorites of the stony class known as *aerolites*. This dual or transitional composition of the Kiowa County "fall" may exceptionally occur in an individual pallasite.

An instance of the kind was found by Dr. Huntington in part of a Brenham pallasite in the Harvard University Museum, and was illustrated in Plate III. of his above-cited paper. The scientific and exhibitional value of the Brenham pallasites is shown by the fact that, while the total "fall" was scattered over an area of about a half mile by two miles, and aggregated well toward a ton in weight, the largest specimen offered in the 1907 price-list of one of the largest firms in America dealing in meteorites, weighs less than five and a half pounds, and is listed at $150.

UNIVERSITY AND EDUCATIONAL NEWS

HARVARD UNIVERSITY has received the sum of $15,000 from Mrs. James Augustus Rumrill, of Springfield, in memory of her husband, who received his degree of A.B. from the university in 1859. It is to be used to establish three scholarships for southern students.

WHILE the British are reorganizing the College of Medicine and the Technical Institute at Hong Kong into a university, the Germans have established a school of university grade at Kiao-chau. It is said that the German government has appropriated $160,000 for its establishment and will contribute $50,000 annually for the support of the institution.

IT is proposed to reorganize the schools of higher education of Algiers into a university.

THE Tulane University of Louisiana during the past year has come into possession of the following amounts: Two million eight hundred dollars from the Newcomb estate. This goes to the Newcomb College—the woman's department of the University—founded by Mrs. Josephine Louise Newcomb as a memorial to her daughter, and to which Mrs. Newcomb before her death gave about one million dollars. Mrs. Ida A. Richardson has made a donation of $50,000 to the university towards the establishment of a chair of botany. By the will of Miss Linda Miles, who died recently in Washington, D. C., the university library is the recipient of $5,000 to purchase books. The following persons have been added to the scientific departments of the university for the session of 1909–10: Charles K. Burdick, New York City, professor of law; Irving Hardesty, Ph.D., University of California, professor of anatomy; Henry W. Stiles, University of Michigan, assistant professor of anatomy; H. Hays Bullard, University of Missouri, instructor in anatomy; D. F. MacDonald, University of Chicago and U. S. Geological Survey, assistant demonstrator in chemistry and geology; J. G. Gage, assistant in clinical medicine.

DISCUSSION AND CORRESPONDENCE

"MARS AS THE ABODE OF LIFE"

THE recent letters in SCIENCE on the geologic facts in "Mars as the Abode of Life" have an origin which readers of SCIENCE should have the opportunity to know. The geologic facts in "Mars as the Abode of Life" are taken from recognized sources, chiefly Dana, Geikie, Dr. Lapparent and recent research; only the weaving together is new. They are not *res gratae* to certain geologists because they clash with a new cosmogeny devised by the Chicago geologist, Professor Chamberlin, who associated with himself for the mechanical and mathematical proof of it, on which all such hypotheses must rest, the assistant professor of astronomy of his university, Professor Moulton. It becomes pertinent, therefore, to consider the basis of their belief which is necessarily astronomic. From the latter writer's exposition of the hypothesis given in most detail in his "Introduction to Astronomy," we shall now quote.

We shall begin with a statement on page 380, which in itself is sufficient to render the reader cautious when he finds himself adventured later upon the exposition. It is with regard to the speed of meteors when they strike the earth. It runs as follows:

> Let us assume provisionally that the meteors are moving around the sun in sensibly parabolic orbits, like the orbits of the comets, and let us find the greatest and least velocities with which they can encounter the earth's atmosphere. If it were not for the earth's attraction they would pass the earth's orbit at the rate of twenty-five miles per second, the velocity being independent of the angle at which they crossed. The earth's

attraction would generate a velocity of nearly seven miles per second in a body falling from an infinite distance into its atmosphere, whether the sun were attracting it or not. The greatest relative velocity will be when the earth and meteor meet, which is $25 + 7 + 18 = 50$ miles per second. The least will be when the meteor overtakes the earth, which is $25 + 7 - 18 = 14$ miles per second.

Now the velocities due to the sun's attraction and to the earth's upon a particle falling to the latter under the action of both can not be added in this simple manner.

The geometric explanation why the velocities can not be directly added is that when each body is supposed to act alone the times involved in their actions are different, while when they act together these are naturally the same. In the latter case the velocity due the sun hurries the particle through the space faster than the earth's pull alone could and so gives the earth less time to act.

For the analytical solution of the problem the reader is referred to a paper in the *Astronomical Journal,* No. 601, in which he will find that the speed the earth can impart depends on the mode of approach, that it can never exceed 2.66 miles a second and may fall as low as 0.53 mile.

We shall now go on to what concerns the hypothesis more directly. The first point we shall mention is found on page 460. In the criticism of the suggestion that "when Saturn extended out to the orbit of the ninth satellite, it rotated in the retrograde direction with the period of this body," the book says:

When the rotation period of the nebulous mass equaled that of its revolution, it filled some space as that indicated by the dotted curve in Fig. 168. Up to this time the tides generated by the sun had increased its moment of momentum by changing it from a negative quantity to a certain positive quantity. After this time the tides generated by the sun decreased its moment of momentum, for they always retarded the rotation. Therefore, if the theory is true, the greatest moment of momentum in the whole history of the Saturnian system should be found when the day and year of its nebula were equal.

The fallacies here are two: (1) It is supposed that the sun-tides would act solely in the Saturnian plane; whereas they would undoubtedly turn the system over in the act. (2) The moment of momentum here considered is that of the solar system; whereas in the generation of satellites it is that of the Saturnian system itself, a totally different matter; so that the supposed destructive proof falls to the ground.

The next point is on page 480, where we are told with regard to the acceleration of a satellite nucleus by a particle m that

It is found by a mathematical discussion that this always results if the eccentricity of the orbit of m is greater than

$$\frac{r}{R} + \sqrt{\frac{MR}{r}},$$

where R is the radius of the orbit of the planetary nucleus around the sun, r the radius of the satellite nucleus around M, and M the mass of the planetary nucleus expressed in terms of the sun's mass. In the case of the earth and moon the limit comes out 0.035, but in the case of the larger planets and closer satellites it is very much larger.

Now the determining equation is

$$\sqrt{\frac{1}{R}} - \sqrt{\frac{M}{r}} = \sqrt{\frac{2}{Rr-2} - \frac{1}{a}}$$

where

$$a(1+e) = R - r$$

whence

$$e = 2\sqrt{\frac{MR}{r} - 2M + \frac{rM}{R}} - \frac{MR}{r} + M + \frac{r}{R}$$

or taking terms of the first order only

$$e = 2\sqrt{\frac{MR}{r}} - \frac{MR}{r} \text{ approx.}$$

Comparing this with the printed value we see that a term of the first order has been omitted and one of the second kept. The result is that with Jupiter and his fourth satellite we have

true value $e = 0.86$
planetesimal value $e = 1.26$

or actually a hyperbolic orbit.

The next point is from pages 478 to 481. The book says, speaking of the effect of particles inside the planet's orbit:

The satellite nucleus is carried forward by the motion of M, while it moves backward in its revolution around M. The latter is a much slower motion than the former. . . . It follows from the

direction of motion of the satellite nucleus that in this case its motion around M will be accelerated by its collision with m. . . . The effect of the accelerations by the scattered material is to enlarge the orbit of the satellite nucleus, and to prevent its being drawn down upon the growing planetary nucleus.

Now the speeds of the larger planets and of their satellites are as follows:

		Speed in Miles per Second: Of Primary in Orbit	Speed in Miles per Second: Of Satellite about Primary
Jupiter		8.1	
Sat.	1		10.7
	2		8.5
	3		6.7
	4		5.1
Saturn		6.0	
Sat.	1		9.0
	2		8.2
	3		7.9
	4		6.3
	5		5.3
	6		3.5
	8		2.0
Uranus		4.2	
Sat.	1		3.5
	2		2.9
	3		2.3
	4		2.0
Neptune		3.4	
Sat.	1		2.7

On the very face of the table it will be seen that six satellites contradict the book. When we get into it deeper we find they all do. Thus if we suppose the colliding particles to be equally distributed in space we have for those within the planet's orbit:

$$\int_{\frac{1}{2}}^{1} \frac{(2a-1)^{\frac{1}{2}} a^{\frac{1}{2}} da}{\int_{\frac{1}{2}}^{1} a da}$$

for their mean velocity at the point of collision; a being the semi-major axis of any particle.

This equals 0.79 of the planet's orbital speed. A result substantially similar is got for any other possible distribution.

From this it appears that all the large satellites of all the large planets have spatial speeds which would cause them to be retarded by such impacts or exactly the opposite of what the book states. So that the supposed proof by this of the planetesimal hypothesis turns out to be a disproof of it.

From what we have said it will be seen that the hypothesis expounded will not work.

Percival Lowell

THE NOMENCLATURE QUESTION

To the Editor of Science: May I add a few words to the excellent letters by Mr. F. N. Balch[1] and Dr. W. H. Dall?[2]

It is necessary first to assume that zoologists in general accept or wish to accept the rules drawn up by the Nomenclature Committee of the International Zoological Congress. The assumption may be a ridiculous one, but it will at any rate be admitted that until those rules are generally accepted further discussion is premature.

I agree with Dr. Dall that most cases can be settled by a rigid application of the code. There are a few in which the interpretation or application of the code may be obscure. These must be remedied either by greater precision in the rules or by the decisions of a court in the manner described by Mr. Balch. There are other cases in which the consequences of the rules are perfectly clear, but at the same time exceedingly unfortunate—so unfortunate indeed are some of them that a great many zoologists are beginning to say "So much the worse for the rules."[3] A phrase has often been used that we should accept the principle of priority "tempered with common sense." This would be all very well if there were such a thing as common sense, but it is notorious that in these matters *quot homines, tot sententiæ*. In a recent paper[4] I have therefore ventured to repeat an old proposal, for which the time now seems to be more ripe, and as that paper may not be very widely seen, I ask you to print the following extracts:

[1] Science, June 25, pp. 998–1000.

[2] Science, July 30, pp. 147–149.

[3] See, for instance, a letter to *Nature* for August 27, 1908, pp. 394–395, signed by many leading British zoologists.

[4] "Some Common Crinoid Names, and the Fixation of Nomenclature," *Ann. Mag. Nat. Hist.* (8), IV., pp. 37–42, July, 1909.

The only possible alternative to strict following of rules is that zoologists should agree to accept as final the decision of some authority by them appointed. The vehicle for such authority already exists in the Nomenclature Committee of the International Zoological Congress, the only body that has any claim to represent either all branches of zoology or all nationalities.

If I may indicate a convenient form of procedure, I would suggest that those zoologists who wish to protect certain names should lay the complete facts of the case before the committee, and should accompany their request for the retention of certain definite names in defiance of the rules by the signatures of as many workers on the group affected as they can obtain. Due announcement of the proposed step should be made in certain widely circulated journals and a reasonable time should be allowed for the reception of protests. The committee should ultimately give its decision, and this decision should be published in the aforesaid journals. A summary of the labors of the committee in this direction would of course be given from time to time in the publications of the International Zoological Congress.

The precise style or mode of appointment of the desired authority does not greatly matter, if only zoologists will agree to accept it. But that it should consist of experts will doubtless be conceded. The ruling may be arbitrary, but it must none the less be made with knowledge of all the circumstances of the case and of the results that will follow from it. It must be clearly understood that the decision is to be made, not because it is in accordance with the rules, but because it is to produce practical convenience.

The next steps appear to be, on the one hand, to find out whether a sufficient number of leading zoologists are in favor of these proposals; on the other hand, to induce the International Committee to undertake this added responsibility.

F. A. BATHER

SCIENTIFIC BOOKS

Die binokularen Instrumente, Nach Quellen bearbeitet. Von MORITZ VON ROHR. Berlin, Verlag von Julius Springer. Pp. 223, 1908.

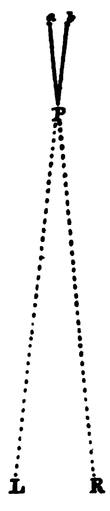
This book has been written by one of a small group of men who have grown into prominence by their original work in connection with the optical establishment of Carl Zeiss at Jena, where for many years the scientific head was Professor E. Abbe. This firm has been known the world over for its high standards; and in photographic and microscopical optics, regarded from both the practical and the purely scientific standpoint, Abbe up to the time of his death was without a peer. His successors, Czapski, Pulfrich and von Rohr have adopted the ideals of their master; and in addition to the details involved in directing the scientific work of a large business they have found time to write books that are accepted as important contributions to optical science.

The first part, or theoretic section, of the present volume includes a general introduction, a chapter on monocular vision, and one on binocular vision, in which account is taken of certain limitations that must be heeded, due to the fact that the eye is not a simple instrument but an optical system which differs in some important respects from artificial instruments. This is true, whether the vision is direct or indirect, with one eye or with a pair of eyes used in conjunction with each other.

The greater part of the book is taken up with the historic development of the subject. The earliest binocular instrument dates back to the beginning of the seventeenth century when Lipperhey, in Holland, constructed the first telescope, and gave to Galileo the starting point for his epoch-making discoveries in astronomy. Lipperhey soon constructed a double telescope consisting of a pair of parallel tubes, each with convex and concave lens, so that by simultaneous use of both eyes double as much light could be received from the same distant object. There was no conception that the images received were in any way different, but the binocular instrument which we call an opera glass, was made prior to 1625, even though not much used. Before the end of that century improvements had been introduced for adaptation to varying interocular distance, and for focusing to suit the varying distances of objects.

Aside from the use of the telescope the superiority of a pair of eyes over a single eye

was maintained as early as 1671 by Cherubin d'Orleans who introduced the theory of corresponding retinal points to account for the perception of a single field of view through a double telescope. The geometric theory of visual triangulation, which has been so much associated with the name of Brewster, antedates his work by nearly a century, having been introduced by Wiedenburg in 1735. If any one man is worthy to be considered the father of physiological optics it is Robert Smith, whose "compleat system of opticks" was published at Cambridge in 1738. Newton had died in 1727, with apparently little knowledge of the eye other than as a mere recipient of light. Smith recognized the advantage of two eyes in securing a more comprehensive view of a near object and thus perceiving spatial depth, and he discovered the important rôle of play of the eyes in completing this perception. To him is due the record of the first binocular experiment with the unaided eyes, that of holding a pair of compass dividers at arm's length, and adjusting the opening so that retinal fusion is secured for the images of opposite terminal points when the visual lines are made parallel. This is now a familiar mode of measuring interocular distance. He modified the experiment by substituting cross vision and thus securing the appearance of a three-legged compass, the middle leg being seen binocularly, the others monocularly. It was but a short step from this to the first recorded stereoscopic drawing (shown in the accompanying diagram). Let the observer's eyes, above R and L respectively, be initially directed to the point, P, of a vertical pin pressing on the paper. Its projection for the right eye is the horizontal line Pa; for the left eye, Pb. Now change the point of fixation to the head of the pin, which is monocularly aligned with a and b respectively. On suddenly lifting the pin away it is apparently replaced by a vertical black line in space, which



is the binocular image of Pa and Pb, while the horizontal monocular images are still seen additionally. The scale of the diagram is necessarily rather small. Neither Robert Smith nor any of his successors for nearly a century applied this stereoscopic experiment to more complex drawings, but through them the way was well prepared for the inventor of the reflecting stereoscope, Wheatstone, a little over seventy years ago.

Von Rohr gives an interesting account of the work of Wheatstone to whom is due the discovery that, since the two retinal images of an object occupying three dimensions in space are sensibly different, the corresponding images on a larger scale may be made on paper or other suitable surface, either by hand or by the new art of photography just then in its infancy; and that these may be suitably arranged for simultaneous binocular observation with the attainment of virtual relief in space. This was distinctly conceived by him in 1833 but not published until 1838. Others had understood the essential conditions of binocular vision, but he was the first to reproduce them artificially and bring them under control. His own discovery of these conditions was likewise independent.

Wheatstone soon had his critics, one of whom, Brücke, stoutly contested his views, laying the utmost stress on corresponding retinal points, motion of the eyes, and especially variations of convergence. Another critic, Tourtual, in 1841, used a modification of Wheatstone's stereoscope and obtained relief effects from a pair of identically similar drawings by slight opposite rotation of these about parallel vertical axes. This seemed to contravene Wheatstone's claim that the pair of pictures must be different. Just forty years afterward the same discovery was independently made by the present writer, who was ignorant of Tourtual's work or his existence; and it was published by him as "a new mode of stereoscopy."[1] He did not, however, find his discovery to contravene Wheatstone's views. On the contrary it was a novel confirmation of them, by which either orthoscopic or pseu-

[1] *American Journal of Science*, April, 1882.

doscopic relief was obtainable at will from a pair of exactly similar drawings by varying the conditions of geometric perspective with regard to two eyes. So far as the experiment is concerned, priority must now be assigned to Tourtual. In Helmholtz's standard work on physiological optics Tourtual's name is several times mentioned in connection with other subjects, but, until recently, his experiments on the subject now under discussion seem to have been completely forgotten.

Wheatstone's most persistent and malignant critic was Sir David Brewster, whose lenticular stereoscope was brought out in 1849. There have been few quarrels in connection with scientific discovery more bitter than this, at least on one side. That Brewster was both wrong and unreasonable seems to have been conceded quite generally. A partial excuse was found in his advanced age, eighty-six years at the time of his death in 1868.

During the decade from 1850 to 1860 the interest in stereoscopy, both on the part of students of science and by the general public was at its height; as great perhaps as the popular enthusiasm about X-rays during the first year or two after Roentgen's discovery in 1895. The possibility of its application to the microscope was soon recognized, and the first binocular microscope was devised and described by Dr. Riddell, of New Orleans, in 1852. It was greatly improved subsequently, especially by Wenham in England, whose contributions on this subject extend from 1853 to 1878. There was a large field for activity in the application of photography to the preparation of double pictures for use with the stereoscope. This was first done by Wheatstone; and the first binocular camera was devised by Brewster in 1849. Dr. F. A. P. Barnard, for nearly a quarter of a century president of Columbia College, published in 1853 a method of taking daguerreotype pictures for the stereoscope, by suitable adjustment of mirrors in conjunction with an ordinary camera. Professor Rood, in 1861, published a method of producing stereographs by hand, and an article on the practical application of photography to the microscope. Among others in America who were active during this period was Professor W. B. Rogers, founder of the Massachusetts Institute of Technology, who in 1855 and 1856 published several notable articles on binocular vision in what was then known as *Silliman's Journal*. Professor Edward Emerson, who has but lately passed away, was first stimulated by his colleague, Rood, and published papers on this subject in 1863 and 1864, his second paper being a vigorous blow against Brewster in the unhappy strife already mentioned. In 1861 Dr. Oliver Wendell Holmes devised what became currently known as the American stereoscope, the only form extensively used in this country since that time. He declined to patent what would certainly have been a fertile source of revenue. Such was the popular demand that according to Brewster's estimate more than a half million of his stereoscopes were made during the first six years after his invention was put on the market by Duboscq, the head of a well-known firm of French opticians. On both sides of the Atlantic the market became overstocked, and after the first dozen years both scientific and popular interest in stereoscopy steadily declined. This decline, in the opinion of von Rohr, reached its lowest point during the decade from 1880 to 1890. The public had been sated, amateur workers found little more to seek, and investigators like Dove and Helmholtz, though still faithful, were turning their attention into other directions.

Accepting these facts it was perhaps natural for von Rohr to assume that in America, the home of practical men, it was useless to look for further work in physiological optics. He has no references to work published in any American scientific journal since 1865. The present writer is indebted to him for some very appreciative words about a form of reversible stereoscope designed for special purposes in 1882, but von Rohr's knowledge of the instrument was obtained from the patent office records, and not from the American or English scientific journals. It was rather unwillingly patented with full knowledge that it had little or no commercial value. But the most important oversight has been

his failure to notice any of the writings of Joseph Le Conte who certainly was well known to a wide circle of readers in this subject. There was, of course, room for difference of opinion about the validity of results, for Dr. Le Conte's first papers were evoked by what he considered to be mistakes made by Claparède and Helmholtz. Between 1868 and 1882 he published more than a dozen papers on physiological optics in the *American Journal of Science;* and the substance of these was afterward incorporated in a volume on "Sight," which passed through several editions. His acuteness as an observer was generally conceded, and the value of his work was certainly greater than that of some whose work had been done in Germany. He was not a mechanical inventor, and no instruments are ascribed to him. This fact may possibly account for failure to recognize his theoretic work in a book on "Binokularen Instrumente," but in this book there is much interesting reading on theoretic matters.

Since 1890 von Rohr finds a renewal of interest in binocular vision to have set in. For this much credit is due to Dr. Abbe and the school of scientific workers stimulated by him. The binocular microscope had passed out of favor, but between 1880 and 1895 Abbe published a considerable number of papers on binocular microscopes and telescopes, in which he described improvements of such marked value as to compel attention. Since his death the work of development has been continued by his successors, and to-day the Optische Werkstätte at Jena constitute the center from which most of the modern binocular instruments have been issued. Among the most important of these are the Zeiss stereo-binocular field glasses with Porro prisms, which are now the standards of excellence in this branch of applied optics.

The third part of von Rohr's book is a systematic arrangement of its contents and a valuable index of the literature of the subject. The care and thoroughness with which this has been prepared is worthy of much praise; indeed it is a model of its kind, and is significant of the dominant standards where optical literature is as completely methodized as mechanical work.

W. LeC. STEVENS
WASHINGTON AND LEE UNIVERSITY,
July 12, 1909

Intracellular Enzymes—A Course of Lectures Given in the Physiological Laboratory, University of London. By H. M. VERNON, M.A., M.D., Fellow of Magdalen College, and Lecturer on Physiology at Exeter and Queen's Colleges, Oxford. London, John Murray. 1908. Pp. xi + 240. Price 7s. 6d. net.

It is only a few years since Professor Hofmeister expressed the view, in a noteworthy lecture,[1] that sooner or later appropriate, specific enzymes would be discovered to account for each of the manifold vital chemical activities of cells. The recognition of the importance of enzymes in these diverse physiological functions has made it easier to understand how a minute cell can be the seat of such a multiplicity of reactions, and how it is possible for the latter to go on side by side in the living protoplasm. Physiological chemistry has lately witnessed an unusual growth of knowledge in the domain which includes fermentative reactions, particularly those associated with the so-called intracellular or endo-enzymes. The well-known books of Green, Oppenheimer and Effront have been helpful as guides to the literature, but Dr. Vernon's volume is the more welcome because it reviews the newest contributions and presents the subject in a style that is actually readable.

It is, indeed, quite a contrast to turn from the conventional chapter on pepsin and trypsin written a dozen or more years ago, to the pages of Dr. Vernon's lectures, in which the rôle of the newly recognized enzymes in various biological processes is described. Historical perspective and not a little critique characterize the author's descriptions. One becomes acquainted with the bearing of enzymes on nucleoprotein and purine metabolism; with the present status of zymase and lactacidase enzymes; the perplexing problems of so-called

[1] Hofmeister, "Die chemische Organisation der Zelle," Braunschweig, 1901.

oxidases and peroxidases; and the possible interrelations of enzymes and functional capacity. Chapters on the constitution and mode of action of enzymes present numerous newer aspects of study—the identity of rennin and proteolytic enzymes, their adsorption phenomena, the laws of enzyme action, and its reversibility, etc. A final chapter deals with some of the more obscure relations of enzymes to protoplasm and their environment.

Dr. Vernon distinguishes the intracellular enzymes from the exo-enzymes found in many secretions "by reason of the facts that they are bound up in the protoplasm of the cells, and, so long as these cells retain their vitality, can only exert their activity intracellularly." It is perhaps doubtful whether a rigid definition of this sort can be successfully defended. The author at any rate has extended his discussion in places beyond the bounds of strictly intracellular functions; and he has dispelled the fear that "the subject of these lectures might at first sight be regarded as too small and unimportant to warrant their reproduction in book form." They are entertaining as well as helpful. Incidentally, as a specimen of good book-making the volume is in striking contrast to the average American product.

Lafayette B. Mendel

Sheffield Scientific School,
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Plankton Investigations of the Danish Lakes. By C. Wesenberg-Lund. Copenhagen, 1908. Pp. xii + 389. Appendix with forty-six tables.

This is the second volume from the pen of Dr. Wesenberg-Lund dealing with the investigations that have been made at the Danish Freshwater Laboratory. In the first volume, published in 1904, the plankton is treated chiefly from the qualitative and quantitative standpoints. In the present one the origin and variation of the Baltic fresh-water plankton forms are discussed. The variations have been studied by statistical methods in a large amount of material that was collected during a period of ten years.

The author attributes seasonal variations to the increase in the temperature of the water in the spring which lowers its specific gravity and viscosity, thus increasing the rate of sinking of plankton organisms. In response to this change, the organisms increase their buoyancy by adaptations which tend to prevent accelerated sinking. The rate of sinking of an organism depends upon its over-weight, that is, how much heavier it is than the water, its form and relative superficial area, and the viscosity of the water. The first two, over-weight and form-resistance, are the biological factors involved and are conditioned by the organism itself. Buoyancy may be increased by reducing the over-weight, or by increasing the form-resistance. The latter may be increased by enlarging the relative surface through a decrease in volume, by enlarging the absolute surface through an increase in the longitudinal axis or the formation of processes, or by gelatinous coverings. Such adaptations constitute seasonal variations and these are discussed in Chapters II. to XI.

Among the diatoms, it was found that *Tabellaria* and *Asterionella* form chains in the spring but they become stellate in summer. There are variations in the size of the cell, also, which are not seasonal but which seem to have a cycle of four to five years.

In *Ceratium hirundinella* the individuals are comparatively small in April and early May and at this time a fourth horn may be entirely absent or only feebly developed. In late May and in June there is a very considerable increase in size (100μ in length in a month) and a fourth horn suddenly develops. In the latter part of July and in August, the individuals decrease in size and the fourth horn nearly or entirely disappears.

Definite seasonal variations were found in only two rotifers, *Anuræa cochlearis* and *Asplanchna*. The variations begin in May and June and the individuals differ most from the typical, or winter form, when the water reaches its highest temperature. Late in the autumn they return again to their normal appearance.

Dr. Wesenberg-Lund thinks there is ample justification for the reduction of the pond and

the various lake forms of the long-spined Daphniæ to one species, viz., *Daphnia longispina*. The winter forms of *Daphnia hyalina, Hyalodaphnia* (*Daphnia*) *cucullata* and *Cephaloxus* can not be distinguished from each other and they remain indistinguishable in the spring till the water reaches a temperature of 14° to 16° C. As the temperature rises above this, these indistinguishable forms change in the course of two or three weeks into the slenderer and lighter summer forms which show all the characteristics of the different races to which they belong. In the autumn all return again to the common race form which is found from December until April. The autumn change extends over a longer period than the spring change.

Bosmina coregoni shows a decided seasonal variation while *B. longirostris* shows only an extremely slight one.

The author reaches the conclusion that local and seasonal variations arose during the glacial epoch and are to be considered as the reply of the organism to the greater differentiation in environment; in part at least to the greater claims made by the rising temperature on the floating power of the organism. The return to the arctic form in winter shows that seasonal variation is a condensed summary of the development which the organisms have undergone from the glacial period to the present time.

The long period of time covered by the collections used for this study, and the large amount of material that has been examined, make this a most valuable contribution to this phase of limnological investigations.

C. JUDAY

SCIENTIFIC JOURNALS AND ARTICLES

The Journal of Biological Chemistry, Vol. VI., No. 4, August, 1909, issued August 12, 1909, contains the following: "The Spontaneous Oxidation of Cystin and the Action of Iron and Cyanides upon it: The Action of Metals and Strong Salt Solutions on the Spontaneous Oxidation of Cystein," by A. P. Mathews and Sydney Walker. In these two papers various influences which affect the spontaneous oxidation of cystin and cystein are described and the action explained in part. Analogies with cellular oxidations are pointed out. "On the Nature of the Chemical Mechanism which Maintains the Neutrality of Tissues and Tissue-fluids," by T. Brailsford Robertson. The maintenance of neutrality in the blood plasma and tissues is largely dependent upon proteins. The reactions by which it is brought about are explained. "Observations on Uricolysis, with Particular Reference to the Pathogenesis of 'Uric Acid Infarcts' in the Kidney of the New-born," by H. Gideon Wells and Harry J. Corper. Uricolytic ferments could not be demonstrated in human tissues: uric acid deposits in kidneys are not therefore due to failure of such enzymes. "Protein Metabolism in Cystinuria, II.," by Horatio B. Williams and Charles G. L. Wolff. Various metabolic tests carried out on a patient with cystinuria. "The Direct Colorimetric Determination of Phosphorus with Uranium Acetate and Potassium Ferrocyanide," by Robert B. Gibson and Clarence Estes. A convenient quantitative method for total phosphorus in organic compounds. "Notes on the Effect of Shaking upon the Activity of Ptyalin," by Marie M. Harlow and Percy G. Stiles. Adsorption is a factor in explaining the curious observation that some enzymes may be destroyed by mechanical shaking. "The Estimation of Total Sulphur in Urine," by Stanley R. Benedict. Oxidation by copper nitrate very greatly facilitates the estimation of total sulphur.

SPECIAL ARTICLES

SALIENT EVENTS IN THE GEOLOGIC HISTORY OF CALIFORNIA

THERE are few regions in the world where the records of geologic history are more complete than in California, for every major division is represented by marine sediments, and many of them also by continental deposits. This is made possible by the geographic position between two ancient and persistent bodies of water, the Pacific Ocean, and the Great Basin Sea, which alternately encroached on what is now California, each one supplying that part of the record which the other

omitted. The Pacific Ocean still washes the western shore of California, now encroaching, and now retreating; but the Great Basin Sea is long since dead, and would be buried, were it not for the later uplifts that rear its old sediments in the mountain ranges of the desert region.

In early Cambrian time sedimentation began in the eastern part of California on the western shores of the Great Basin Sea, and kept up, almost without interruption, until the middle of the Jurassic. During this long period the greater part of the state appears to have been above water, although during the Santa Lucia epoch (Paleozoic?), calcareous sediments were laid down in the Coast Ranges, and during the Carboniferous the Great Basin Sea spread westward and southward over much of the region of the Sierra Nevada. In the Permo-Carboniferous, California, although remote from the center of activity, felt the effects of the Appalachian revolution, for an uplift began along the axis of the Sierra Nevada, manifesting itself in great outpourings of volcanic tuffs, which now are preserved as greenstones, showing by their marine fossils that they were deposited in the sea. Further west, the calcareous sediments of the Santa Lucia Mountains were raised above the sea and changed into marbles and schists.

The Appalachian revolution restricted, but did not obliterate, the Great Basin Sea, nor did it confine the relentless advance of the Pacific Ocean, for during the Jurassic marine sediments were laid down along the Coast Ranges, and along the sides of the Sierra. The Franciscan series has preserved this record in the Coast Ranges, and the Mariposa formation in eastern California.

The Cordilleran revolution began in the Great Basin Sea in the middle of the Jurassic, when that body of water, after many vicissitudes, finally went dry, and has never since been covered by salt water, although in later ages Tertiary and Quaternary lakes have been scattered over its dead basin.

This elevation culminated, in late Jurassic time, in the upturning and metamorphism of the Triassic and Jurassic sediments of the Sierra Nevada, and the Franciscan beds of the Coast Ranges. Since that time the Sierra Nevada has been above the sea, subjected to continuous erosion, and there we see the deeper results of metamorphism. The Coast Ranges, on the other hand, have been buried under the later Cretaceous and Tertiary sediments, and the deeper products of metamorphism are little exposed. The glaucophane schists of the Coast Ranges are evidences of rather shallow hydrothermal metamorphism, while the great masses of thoroughly altered rocks and auriferous veins of the Sierra Nevada show the deep-seated action in that region. This explains the fundamental difference between the metamorphic rocks of the two areas, where the phenomenon was contemporaneous, and the rocks affected were similar in the beginning.

During this epoch along the western coast, from Oregon to Lower California, there was much igneous activity, and great masses of serpentine are now seen throughout the Coast Ranges, the results of alteration of the peridotite dykes that were intruded into the Franciscan sediments.

It is probable, also, that the Cordilleran revolution was something more than a mere orogenic disturbance, for it marks a change from the warmth of the Middle Jurassic, with its cycads and reef-building corals, to the cooler epoch of the Upper Jurassic, with its scanty boreal fauna. The Middle Jurassic was of tropical type, from Mexico to Alaska, and uniform up to Franz Joseph Land. The Upper Jurassic, on the other hand, was of Boreal type from the Arctic Region down as far as California, and for a short epoch in the Portland these conditions extended down as far as Mexico.

After this mountain-making epoch near the close of the Jurassic, the sea again encroached on the uplifted area, and the Knoxville sediments were laid down on the western border of the Coast Ranges. The lower Knoxville beds contain a fauna closely related to that of the Mariposa, still with Jurassic types of *Aucella*, and with the same poverty of other animals.

But the upper Knoxville beds, while still retaining reminiscences of the Boreal Region in *Aucella* and a few other forms, show a preponderance of life characteristic of more favorable conditions. *Aucellas* of northerly habit mingle with cephalopods that did not belong in the Boreal Region, and on the nearby land cycads abounded. The line between Jurassic and Cretaceous should be drawn, not at the beginning of the Knoxville, but between the lower and the upper Knoxville beds; the former belonging to the Portland and Aquilonian, while the latter belong to the Neocomian.

With the opening of the Horsetown epoch, the revolution of faunas and floras was complete, the climate had become tropical, and swarms of *Trigonias, Nautilus* and *Ammonites* like those of India and eastern Africa occupied the shallow seas of northern California. These beds were deposited only in a narow strip from Shasta County down to the neighborhood of Mt. Diablo, the rest of the state being above water.

While the Paleozoic and the earlier part of the Mesozoic were characterized by the formation of immense masses of limestone, and the Jurassic and the Knoxville by the deposition of thick beds of shale, the middle Cretaceous inaugurated a sandstone-forming era, which lasted through the entire Tertiary.

During the Upper Cretaceous Chico epoch the climatic conditions and faunal geography remained unchanged, but the sea encroached still farther on the land, reaching the foot of the Sierra Nevada, where, in Butte County, the unaltered and slightly tilted sandstones of the Upper Cretaceous may be seen resting upon the upturned, metamorphosed and eroded rocks of the backbone of California.

By the end of Cretaceous time the subsidence and erosion of the western part of the continent had almost established a connection between the Pacific Gulf in California and Oregon and the old Mediterranean Sea of the Mississippi Valley. The intervening isthmus not covered by salt water was worn down to base-level, and wide expanses of flats were covered with marshes, which eventually formed coal, preserving a very similar flora from the outliers of the Mississippi Valley almost to the Pacific coast. These coal-forming conditions reached far up into Alaska, where almost under the Arctic Circle types of plants flourished that, to-day, could not live in the open north of Mexico.

In Eocene time the climatic and geographic conditions remained the same as in the Upper Cretaceous, but the sea had encroached still farther on the land, and the base-leveling of the backbone of the continent was more complete. The aged rivers began to deposit their loads of sediments, beginning the formation of the auriferous gravels, the first great source of wealth of the Pacific coast.

Tropical conditions still prevailed up as far as Alaska, and coal was still formed abundantly where vegetation is now scanty. If a geologist in western America had first named the geologic systems, the Eocene would have received the name "Carboniferous," for most of the coal on the west coast belongs to that epoch. During the Eocene, also, a temporary connection was established between the Pacific and the Atlantic basins, for in California and Oregon the Atlantic "finger-post of the Eocene," *Venericardia planicosta*, is found along with Pacific types.

Before the Miocene epoch this Atlantic connection had ceased, and the faunas of the later Tertiary were wholly of the Pacific type. The lower Miocene was still warm, for we find in its fauna a *Nautilus* still persisting, and other genera now found only in southern waters. Quiet accumulation of sediments with abundant organic remains, diatoms and radiolaria, was going on in the Coast Range region. From these the petroleum, which has added so much to the wealth of California, was afterwards distilled, in the great disturbance that took place after the close of the Monterey epoch of the middle Miocene.

The vast outpouring of the Columbian lava flow, which covered an area of more than two hundred thousand square miles, including the northeastern part of California, occurred

about the middle of the Miocene, and the Coast Range disturbance was probably a local phase of the same revolution.

In the upper Miocene the climate was no longer subtropical, but warm-temperate and moist, like that of the states bordering the present Gulf of Mexico. Marine animals like those of our time abounded in the waters, but along with them were some southern forms. And on the land elms, walnuts, hickories and laurels flourished, indicating a temperate, rainy climate, moister if not milder than that of to-day in the same region.

In the Sierra Nevada in this epoch there were large rivers, not running swiftly in deep canyons, as they do now, but winding slowly down low grades, overloaded with sediments, the auriferous gravels. These dead rivers, which must have run on a low plain not far above sea-level, are now found high up in the Sierra Nevada, with their channels buried deeply under later lava flows, and warped by later orogenic movements.

In the Pliocene the warm-temperate types of plants have disappeared temporarily, and the salt-water faunas, too, show a change for the worse. The fresh-water Pliocene lake beds also show the influence of a cooler climate, for while many of the fossil mollusca are the same as species now existing in that region, others that are still living are now found only in the Klamath Mountains.

Now the land had begun to encroach on the sea, and the shore was receding westward. The whole west coast was rising, and the salt waters no longer reached to the foot of the Sierra Nevada, nor even to the great valley. But the elevation was not uniform, for valleys in the Coast Ranges that had been cut during the Miocene were filled with sediments during the Pliocene, which was made possible by local subsidence along the coast. The immense deposits of the Great Valley belong partly to this epoch, and partly to the Quaternary, but they are wholly of fluviatile origin. These gravels and silts have been bored into to the depth of three thousand feet in the middle of the Great Valley, and still bed-rock was not reached.

During the Pliocene the Sierra Nevada was elevated again, and the rejuvenation of the streams carried the sediments out of the mountains to the flats of the valley floor, piling up the gravels and clays now known as the Tulare formation. California of that time was very much like California of to-day, with a great mountain range on the east; in the middle a long, broad valley, low-lying, and covered in many places by fresh-water lakes; and on the west, a long, low, narrow mountain range. On the submerged narrow coastal plain, and in troughs parallel to this range, were laid down the marine Pliocene sediments.

About the close of the Pliocene, and in early Quaternary, the elevation of the west coast continued, causing deep canyons to be excavated by the vigorous streams, in the Sierra Nevada, and in the Coast Ranges. This epoch has been called by Professor Le Conte the Sierran epoch. The results of this erosion are still seen in the deep canyons, the most striking scenic features of the Sierra Nevada, but those of the Coast Ranges are now seen only on hydrographic charts, for they are now buried two or three thousand feet under the ocean. This shows that in early Quaternary time the coast stood two or three thousand feet higher than now. The record of that time is purely one of events, for the sediments that were laid down in the bordering sea are now covered by the ocean, and the region that is now above sea-level stood too high for much deposition. The Sierran epoch corresponds to the pre-Glacial or Ozarkian epoch of the eastern states.

Increasing cold accompanied the period of elevation, and this culminated in the Glacial Epoch, in which the Sierra Nevada was covered by a continuous sheet of ice. The ice made its way down sheltering canyons to places that are now 3,500 feet above sea-level, but which then stood several thousand feet higher. This means that in the Glacial Epoch the climate of California was very similar to that which now prevails on the Olympic Peninsula in Washington, for in that region glaciers still come down to 6,000 feet above the sea, the climate is cool and rainy,

Synopsis of Quaternary History of California.

<table>
<tr><td>Recent.</td><td colspan="2">Subsidence epoch of Golden Gate and other bays.</td><td colspan="3">Invasion of Golden Gate River System by tide water and formation of the harbors of the West Coast. This subsidence has been going on until very recent time, for Indian shell mounds around the Bay of San Francisco are partly flooded.</td></tr>
<tr><td rowspan="4">Quaternary.</td><td>Terrace Epoch.</td><td>Terrace.</td><td colspan="3">Period of uplift and scouring out the channels filled during the San Pedro epoch, forming terraces in the fluviatile sediments of San Benito Valley, and nearly all the valleys of the Coast Range. The youngest (lowest) terraces of the San Pedro truncate the upper San Pedro beds and are later than they. The older (higher) wave-cut terraces of the West Coast probably date back to the Sierran epoch.</td></tr>
<tr><td>Upper San Pedro.</td><td rowspan="2">Champlain.</td><td rowspan="2">Epoch of depression along the coast. Coast stood 300–700 ft. lower than now.</td><td>Warm water. Marine fauna.</td><td rowspan="2">Epoch of filling preexisting valleys with gravels and other fluviatile sediments. Seen in the Salinas Valley, Santa Clara Valley, San Benito Valley and the Great Valley.</td></tr>
<tr><td>Lower San Pedro.</td><td>Cold water. Marine fauna.</td></tr>
<tr><td>Sierran Epoch. Probably longer than all the rest of the Quaternary.</td><td>Glacial.
Pre-Glacial.</td><td colspan="2">Period of elevation of the West Coast, forming the great canyons off the Sierras and the submerged canyons of the coast. A period of no marine sediments (now exposed). In part contemporaneous with the Glacial Epoch, for the glaciers of the Sierra Nevada came down some of the canyons.
The West Coast then stood about 3,000 ft. higher than now, as shown by the submerged Monterey Bay canyon at a depth of 3,000 ft.</td><td>The principal terracing along the coast took place at this time, and also the Channel Islands were connected with the mainland, as shown by the Santa Rosa Mammoth.</td></tr>
<tr><td>Pliocene.</td><td>Merced beds.</td><td></td><td colspan="3">Period of depression and filling of troughs with marine Pliocene sediments, and formation of great Pliocene lakes above sea level.</td></tr>
</table>

and the forests consist almost entirely of conifers.

During the period of elevation the Channel Islands off the coast of southern California were connected with the mainland, allowing mammoths to make their way across on dry land. The channel was then a gulf, not unlike the present Gulf of California, and may appropriately be called the Santa Barbara Gulf.

After the Glacial Epoch had passed, there came another era of subsidence, but this time on a small scale, affecting only the immediate shore-line, which stood for a time from three to seven hundred feet lower than now. During this period were accumulated the marine San Pedro beds, known chiefly in the Santa Barbara Gulf. At first the water was a little colder than at present, allowing marine life now characteristic of Puget Sound to flourish as far south as San Pedro. Then it became warmer, and, for a short time, species that today can not live north of Lower California made the Santa Barbara Gulf their home. This history is remarkably like that of New England, where a warm Champlain epoch of depression followed the Ice Age.

After the San Pedro epoch there came on the west coast a renewed elevation, causing the streams to terrace the alluvial deposits that had filled the lowered valleys in the preceding epoch. This, too, has its counterpart in the Terrace epoch of New England. This time has left us no marine record, but only terraces on the streams, and along the shore.

The last phase in the physical history of the west coast is the recent subsidence that allowed the sea to encroach on the river valleys, forming the Bay of San Francisco, and other bays along the coast. This has been going on almost into modern time, for Indian shell mounds, apparently made by the same race

that still exists in California, have been flooded by the continued subsidence of the Bay of San Francisco.

It is remarkable and little appreciated that the physical history of the Pacific coast should be so like that of the eastern coast of America. On both sides we have the preglacial, Sierran or Ozarkian, elevation of the land, and erosion of deep canyons; the southward advance of the glaciers; the Champlain, or San Pedro, subsidence and amelioration of the climate; the Terrace elevation and moderate erosion; and the recent subsidence that made the fiords of New England and of Puget Sound, the gentler bays of California and Oregon on the west, and the sounds of the Atlantic states on the east. On both sides of the continent submerged canyons run out to sea, marking the course of drowned rivers of early Quaternary time, now forming channels of navigation, making possible the maritime commercial centers of the east and the west.

James Perrin Smith

THE WINNIPEG MEETING OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

The seventy-ninth annual meeting of the British Association for the Advancement of Science was held at Winnipeg, Canada, August 25 to September 1, under the presidency of Sir J. J. Thomson, professor of experimental physics in the University of Cambridge. This was the fourth time only in the long history of the association that it met outside of the British Isles; the other three being Montreal 1884, Toronto 1897, and South Africa 1905. The westward movement of the Canadian meetings and the increasing frequency of the meetings outside of the British Isles afford much food for thought, and the former was the source of many comments as regards the rapid development of central Canada and of Winnipeg in particular.

The inaugural meeting, held in the Walker Theater on the evening of August 25, was opened by the rising of Professor Geo. Carey Foster, who asked Major MacMahon, the general secretary, to read a letter from the retiring president, Francis Darwin, who was unable to be present. After the reading of this letter the president-elect, Sir Joseph Thomson, read his inaugural address, dealing with a wide range of educational matters in a very scholarly manner. His expressed wish that the interchange of students between the British Isles and Canada should increase was received with loud applause.

After this address Mayor Evans, of Winnipeg, welcomed the association and delivered a very interesting address, which was in part as follows:

"To the men and women who have earned by their services the position of leaders in the work of science and to the association which is devoted to the encouragement of scientific investigation and the spread of scientific truth, we would do all honor and to them we extend a hearty welcome to our city and to our country. To those who are present from the nations of continental Europe and from the United States we offer a particular welcome to this portion of the British empire, for beyond the value of their contributions to the success of this meeting from the scientific standpoint, their consent to participate in the work of this association must strengthen among the nations the realization of unity of interests in the fundamental concerns of life, which should, and we believe will, tend more and more to lessen the causes of serious dispute.

"But cosmopolitan as it is and must be in its spirit, we do not forget that this is the British Association for the Advancement of Science, an institution of our own empire, with its origin and home in the heart of that empire. To it, as an evidence of the vitality of the higher life of the empire and as a most important agency in the improvement of the material conditions of the British peoples, as well as in the stimulation and discipline of their rational powers, we give a welcome that draws a quality from our common patriotism. We have by custom no ceremony that bestows the freedom of the city, but with all the cordial significance of that formality we bid you to be free in Winnipeg. Our city is such as you may see it. The observations of a day will, however, give you only the statical facts of the city, whereas the real Winnipeg is essentially a study in dynamics. It has trebled its population in the past eight years and is increasing to-day in that ratio. Literature is distributed to its citizens in forty-five languages and dialects and immigrants are daily coming from all quarters of the earth. It is the principal city of central and western Canada, so situated between the Great Lakes to the north and the international boundaries that all the traffic in Canada between the east and the west does and must pass through it. Its business is expanding in proportion to the remarkably

rapid development of western Canada. Its buildings, its public improvements and its institutions represent our efforts to meet the needs that are growing from hour to hour. In these respects we trust that Winnipeg may prove of interest to you."

The sectional meetings opened on Thursday morning and continued until the programs were completed with the exception that all of Saturday was devoted to excursions to various points of interest. By means of the many joint meetings and the numerous excursions, the members of the various sections were brought into closer contact and this contact between the scientists representing various fields of knowledge is one of the most important features of the Associations for the Advancement of Science. Perhaps the most important factor to promote such contact at the Winnipeg meeting was the excursion to the Pacific coast for which the western provinces and cities provided the financial support.

A feature which aroused considerable comment on the part of the members from the United States and even of those from England was the great strength of Section A. Not only did this section have an imposing program, but the interest at its meetings and the large number of distinguished scientists who participated in its discussions were most gratifying evidences of the vigor and health of the section. It would be of interest to inquire to what extent the meetings of the British Association are responsible for the long line of distinguished mathematical physicists who adorn British scholarship; and also to inquire to what extent the separation of mathematics and physics in the American Association has contributed to our lamentable and disgraceful lack of such physicists. The fact that the president of the association is a member of this section contributed to the interest in its meetings. For the consideration of the more technical papers the section met in subsections and even with this arrangement the meetings extended through September 1.

The organization of a subsection devoted to agriculture was a special feature of this meeting, but its success inspired the hope on the part of those especially interested that it might become a permanent feature of the association. It seemed especially appropriate that such a subsection should be inaugurated at the Winnipeg meeting in view of the special interests of this country. This was only one of many ways in which the association made direct returns for the great liberality exhibited by Canada in general and by Winnipeg in particular, in providing for the entertainment of their distinguished guests. Another direct return was the arousing of interest in the University of Manitoba and its needs for better equipment. The facilities for higher education, especially the library facilities for specialists, have not been developed as rapidly as the rich material advances might lead one to expect. It seems probable that the most important local result of this meeting will be a more rapid development of the provincial university and a deeper appreciation of the importance of research.

While the total attendance of members and associates, about fourteen hundred, was only about half of the maximum number, yet the meeting was a little larger than the one held at Toronto and the ratio of noted scientists was unusually large. About one hundred and fifty of the members and associates came from the United States, and about five hundred from Europe.

Notwithstanding the fact that Winnipeg has over one hundred and twenty thousand inhabitants, the daily papers devoted much space to the reports of the meeting and their reports were favorable and unusually reliable. The Manitoba *Free Press* on September 1 said on the editor's page, "To-day's sessions bring to a close the most important meeting ever assembled in Winnipeg." The city was beautifully illuminated every night and the front of the City Hall had an arrangement of lights forming, in large letters, the words "Welcome British Association." Directions for finding the various meeting places were posted in the most conspicuous places throughout the city and the little boy who wrote on one of these posters "big guns only" may have given clear expression to the prevailing view. At any rate the attention and favors shown by the inhabitants of Winnipeg to the members of the association might imply such a view and the arrangements for the comfort of the members left nothing to be desired.

The next annual meeting of the association will be held in Sheffield, England, from August 31 to September 7, 1910, under the presidency of Rev. T. G. Bonney, D.Sc., LL.D., F.R.S., emeritus professor of geology, University College, London. According to the established custom of the association the presidents and other officers of the sections will be appointed by the council about Christmas. The general treasurer, Professor John Perry, F.R.S., and the general secretaries, Major P. A. MacMahon, F.R.S., and Professor W. A. Herdman, F.R.S., were reelected at this meeting.

G. A. Miller

SCIENCE

Friday, September 17, 1909

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of Science, Garrison-on-Hudson, N. Y.

PROFESSOR SIMON NEWCOMB AS AN ASTRONOMER

Professor Newcomb has narrated at considerable length the personal incidents of his scientific career in his book "The Reminiscences of an Astronomer," and to that source the reader desirous of knowing them may be referred. Here it is intended to note only the scope and characteristics of his more important contributions to astronomy. While Professor Newcomb wished always to be accounted a mathematician, his work seems motived by its possible application to astronomy, and no very weighty contribution from his pen has accrued to pure mathematics.

While still an assistant in the office of the American Ephemeris, then at Cambridge, Mass., Professor Newcomb began his career as an astronomer by discussing the question of the origin of the minor planets. Induced by a too great confidence in the law of Bode as to the relations of the mean distances of the major planets, Olbers had ventured to put forward the hypothesis that the minor planets were the fragments resulting from the disruption of a single major planet. This hypothesis necessitated the condition that the orbits of the minor planets at some past epoch must have had a point in common. By computing the secular variations of the elements of the minor planets, Professor Newcomb showed that at no time could this condition have been fulfilled. Thus there was no reason for entertaining the theory of Olbers.

After Professor Newcomb's appointment to a professorship of mathematics in the U. S. Navy and his removal to Washington, he was much engaged with the instruments

of the U. S. Naval Observatory, chiefly the Pistor and Martin's transit circle, but found time to investigate the distance of the sun, concluded from all the methods. His result for the constant of solar parallax was 8″.848, a value adopted in nearly all the ephemerides for quite a lengthy period. It is too large chiefly on account of the large weight attributed to the determination from Mars, whose observation is subject to systematic errors, at that time unsuspected.

About the same time Professor Newcomb undertook the investigation of the orbit of Neptune and constructed general tables of its motion. As material he had the two observations of Lalande and those of eighteen years following the discovery of the planet. This investigation, published in the *Smithsonian Contributions to Knowledge,* met an urgent need of practical astronomy at that time.

As the secure reduction of astronomical observations is a matter of prime importance, Professor Newcomb contributed to the *Washington Observations* for 1870 an appendix dealing with the right ascensions of the equatorial fundamental stars. His aim was to eliminate as far as possible systematic errors of a personal or local nature and thus obtain a homogeneous system. This is an admirably conducted investigation and has served as a foundation for whatever has been since accomplished in this subject.

The elegant method of treating the motion of the moon by Delaunay, published in 1860, led Professor Newcomb to consider this subject; thus we have his memoir in Liouville's *Journal* for 1871 on the planetary perturbations of the moon. The investigation is very neat, regard being had to the early epoch of its composition, but the final equations derived are precisely those which result from Delaunay's method.

Having treated Neptune Professor Newcomb next undertook a similar piece of work for the adjacent planet Uranus. This was a heavier task than its predecessor on account of the longer period covered by the observations. These theories of the two planets have been superseded by the investigations of Professor Newcomb while director of the *American Ephemeris,* but that of Uranus was welcomed by astronomers as a great improvement on the discussion of Bouvard. As in the case of Neptune, the investigation of Uranus appears in the *Smithsonian Contributions to Knowledge.*

In the same collection for the following year Professor Newcomb has a memoir on the general integrals of planetary motion. The aim of this paper is to show how to avoid powers of the time as multipliers of the different portions of the algebraic expressions arrived at. The thus modified expressions have since received the name of Lindstedt's series and are the chief subject of investigation in M. Poincaré's work in the line of celestial mechanics. This paper is a worthy beginning for what was to follow.

Only a few years after the introduction of Hansen's lunar tables for computing the places for the ephemerides it was seen that observation was marching away from them. From the character of the deviation they could only be attributed to an imperfect determination by Hansen of the secular and long-period terms. Always interested in the theory of the moon, Professor Newcomb undertook to see what light could be thrown on the matter by observations made before the epoch 1750, chiefly in the form of times of beginning or ending of solar and lunar eclipses and occultations. This involved a heavy load of numerical computation and a careful research for material in the libraries and observatories of Europe. The results of this labor appear

in an appendix to the *Washington Observations* for 1875. The memoir led to large modifications in our estimation of the value of Hansen's theory and it still must serve as a foundation to all future investigations in the subject.

In 1877 Professor J. H. C. Coffin was retired from the U. S. Navy on account of age and thus the *American Ephemeris* was left without a head. Professor Newcomb was appointed to the vacant place. He immediately formed the grandiose scheme of reforming nearly all the fundamental data involved in the construction of an astronomical ephemeris. One would have been inclined to predict the failure or, at least, only partial success of such a scheme; but Professor Newcomb, by his skilful management, came very near to complete success during his lifetime; only tables of the moon were lacking to the rounding of the plan. It must, however, be noted that he was fortunate in finding a few men ready to hand in relieving him not only of the drudgery of numerical calculation, but, in some cases, of devising methods. To aid matters he founded a collection called *The Astronomical Papers of the American Ephemeris* to contain all the memoirs the carrying out the scheme should give occasion to. A large proportion of these memoirs is the work of Professor Newcomb. So numerous are they that we must be content with noticing only the more striking and important ones.

The transits of Mercury from 1677 to 1881 were discussed, with the principal result of corroborating Leverrier's assertion of 40″ in the secular motion of the perihelion unaccounted for.

In the years 1880–1882 Professor Newcomb made a determination of the velocity of light by the Foucault method. The construction of the instrument and the mode of handling it enabled a very large angle of deviation to be obtained; and thus an extraordinary degree of precision in the result was hoped for. Although this hope was not completely fulfilled, nevertheless, the concluded value is far in advance of all previous determinations.

Shortly after, Professor Newcomb exhaustively treated the transits of Venus in 1761 and 1769 with the object of obtaining the constant of solar parallax and the position of the node of Venus.

In another memoir was derived the value of the constant of nutation from material afforded by observations with the transit circles of Greenwich and Washington.

Professor Newcomb deemed that improvements could be made in the mode of deriving the periodic expressions needed in the subject of planetary perturbations. His method of treatment is elaborated in a memoir in the *American Journal of Mathematics,* Vol. III., and, at greater length, in a second memoir in the *Astronomical Papers,* Vol. III.; and, finally, application is made to the four interior planets in a third memoir contained in the latter volume. For certain long-period inequalities in these planets it was found convenient to employ expressions involving time-arguments; this led to the composition of two memoirs in Vol. V., of the same collection.

The secular variations of the elements of these planets are derived and the mass of Jupiter determined from observations of Polyhymnia in the two following memoirs of the same volume.

Professor Asaph Hall having found that there was a rather rapid retrograde motion of the line of apsides of Hyperion, Professor Newcomb explained this from the point of view of the variation of elements. By an inadvertency at the very end of his memoir he failed to obtain a correct value for the mass of Titan, the disturbing body.

The completion of these preliminary investigations enabled Professor Newcomb to proceed at once to the composition of a me-

moir on the elements of the four inner planets and the fundamental constants of astronomy, which appeared as a supplement to the *American Ephemeris* for 1897. This memoir contains the data on which are founded the tables of these planets, published shortly after. In 1899 Professor Newcomb completed his work on the six major planets, he had undertaken to revise, by the publication of tables of Uranus and Neptune.

While all these investigations in the planetary theories were going on Professor Newcomb must have found time for attacking his subject of predilection, the lunar theory, for we have a lengthy memoir by him on the action of the planets on the moon, contained in the volume last mentioned. This paper must have cost him an enormous amount of labor; he seems to be determined that no inequality of sensible magnitude should escape him.

The tables of the planets being out of the way, Professor Newcomb next turned his attention to the fixed stars. Being present at the Paris Conference of 1896 on a common international catalogue of fundamental stars, he obtained the assignment of the subject of precession as his share of the work to be undertaken. Within a year he had the work done, having derived a value of the principal constant involved which is probably as good as the condition of the data at the time allowed.

This memoir is naturally followed by another containing a catalogue of more than 1,500 stars reduced to an absolute system and to be employed as fundamental.

In March, 1897, Professor Newcomb, having arrived at the age limit, was retired from the office of the *American Ephemeris*. Many of his unfinished jobs were carried to completion under the nominal superintendence of others.

At the foundation of the Carnegie Institution of Washington Professor Newcomb secured the privilege of prosecuting his researches on the motion of the moon under its auspices. Here, until the end of his life, he labored assisted by a small but very able corps of assistants. Although the period of time was short a long memoir on the planetary inequalities has appeared.

The last contribution of Professor Newcomb to science is an article in the *Monthly Notices* for January, 1909, exhibiting the deviations of the moon's mean longitude from the best theory that, so far, has been devised.

In the intervals of leisure between his labors of a more technical kind Professor Newcomb composed a book on "Popular Astronomy." Although the rapid advance of the science in the more than thirty years since its publication has caused it to fall behind, it still remains the best composition on the subject.

Professor Newcomb contributed a vast number of notes on almost every conceivable topic in astronomy and the allied sciences to the scientific periodicals. (In this connection it may be useful to state that the Royal Society of Canada has published a bibliography.) He had the management of the construction of tables for the Watson asteroids. He found time to treat questions in economics and psychics and even wrote a novel. No matter how many tools he had in the fire, he was always ready to add to them. His journeys to observe total solar eclipses, transits of the interior planets and to collect scientific data from the observatories and libraries of Europe are too numerous for mention.

With almost universal consent, it is admitted that, for the last forty years of his life, Professor Newcomb stood at the head of the cultivators of the astronomy of position. And he did not have to complain of lack of appreciation by his fellows: after he had got fairly started in his sci-

entific career, a continual flow of medals, prizes, degrees and honorary memberships in scientific societies came for his reception, till the possibilities were exhausted. His departure leaves a great gap in the band of astronomers. It will be long before we again have one of equal untiring energy.

G. W. Hill

SIMON NEWCOMB

In the death of Professor Newcomb American astronomy has lost its chief ornament and American science in general one of its most commanding figures. His exact relation to contemporary science must be determined by the judgment of future times but to those who have been his associates during any part of the past half century his career bulks too large for oblivion, too generous to be dismissed without some word of appreciation. The common incidents of his life, its offices and honors, may here be dismissed summarily since he has given in his "Reminiscences of an Astronomer," an autobiography that must always remain their most authentic exposition.

Born in Nova Scotia, of New England ancestry, and returning in early manhood to the land of his fathers, there to build a scientific career upon a youthful experience containing scant preparation for such work, he found in the Nautical Almanac office, then at Cambridge, Mass., a position which he himself describes as his first introduction to the world of sweetness and light. Appealing equally to his tastes and talents this work upon the almanac proved decisive of his whole career in which for fifty years problems of celestial mechanics constituted the core about which all other activities centered. Even upon his deathbed his mind was fixed upon the last of the problems that had been marked out as his life work and with its completion he sank visibly and rapidly to the end. Newcomb was, however, far from being a man of one idea. During his long professional career duty and inclination alike brought him into relation with nearly every phase of astronomical activity; popular exposition and the writing of text-books, the design and use of astronomical instruments, research into astronomical history and the utilization of its ancient materials, the organization of individual effort either for such special cases as a transit of Venus and a congress of science, literature and art or for continuous relationship in a permanent scientific body, such as the Astronomical and Astrophysical Society of America or the National Academy of Sciences in both of which he was active and influential. The newer fields of spectroscopic and photometric research in astronomy into which he did not profess to enter as an investigator, commanded his active interest and especially in his later years he was solicitous to combine their results with those of the older branches into a consistent whole.

But no one science, however diverse its paths, seemed to Newcomb an adequate field for the exercise of his powers and numerous were his excursions beyond the bounds of astronomy, *e. g.*, into economic theory, physics, politics, fiction and occult psychic phenomena, most of which, however, can be expected to contribute but little to his permanent fame. In the field of his first choice, theoretical astronomy, while his attainments were large and his powers great, it may be doubted whether posterity will rank his work as of the first order. His greatest achievements unquestionably lie in the border land between theory and practise where an enormous body of observed data has been utilized by an army of computers under

his direction and guidance, in determining the fundamental constants of astronomy, together with the elements of the planetary orbits, and in building upon these tables of the motions of the planets and the positions of the fixed stars that are now in daily use by the astronomers of the world.

Recognition and honors came to him in most unusual degree and from the most diverse sources, but his medals and diplomas, although obviously prized, were rarely exhibited. The ornaments of his home were his three daughters and his wife, Mary Hassler, to whom he was married in 1863. All of these survive him. Although socially inclined and fond of the amenities of life, Newcomb's leonine appearance and conscious dignity of bearing were not infrequently a source of awe to younger men who found it difficult to cross the supposed barrier between them. To the dullard or impostor the barrier was sometimes made real by a word of cutting sarcasm, but toward what he conceived to be real merit Newcomb was always singularly appreciative, seeking to bring out the man of promise and to secure for him recognition through every legitimate means. By none save his own kin will his departure be more sincerely mourned than by his juniors in astronomy whose careers have been furthered by his kindly aid.

G. C. C.

THE ANNUAL REPORT OF THE UNITED STATES COMMISSIONER OF EDUCATION FOR 1908

A FEW years since on the editorial page of the most dignified of our semi-popular magazines it was remarked with facetious seriousness that the annual report of the United States Bureau of Education was without exception "the dullest book in the world." Deserving or not of this charge, it will be generally admitted that the two fat, black-garbed volumes, the issuance of which had become an annual habit of the bureau, did possess, for both the initiated and the disinterested, a forbidding outwardness, which was not much altered by a survey of the twenty-five hundred odd pages of contents. Whatever their value to the cause of American education, very great in the credited judgment of many, these reports were not for those who would read as they ran. However this may have been in the past, within the brief three years of his commissionership, Dr. Elmer Ellsworth Brown has wrought reforms in the publications of the bureau which are certain to develop a more wide-spread recognition of the genuine service which it is possible for the federal government to render to American schools and American education. The annual report of the bureau for 1908 well illustrates the more important of these reforms; attractiveness in make-up, promptness of publication, condensation of contents, timeliness of topics, simplification and interpretation of the detailed array of statistics, and a cautious editorial supervision.

For the first time since the establishment of the bureau the funereal black binding of the report has been discontinued and the volumes appear in an artistic soft toned olive. This is a reform certainly meriting commendation. Why should not the publications of the Bureau of Education have advantage of an inviting exterior? Perhaps, too, the influence of the example may be felt with the official publications of other governmental departments and bureaus.

The prompt appearance of the report—the first volume being distributed before the close of 1908 and the second early in 1909—greatly enhanced its value. Formerly the annual reports of the bureau were one or two years behind. There were undoubted obstacles in the way of prompter publication which were not easily overcome. That they could be overcome has been effectively demonstrated, much to the relief of those who believe that the Bureau of Education should furnish authentic data and information concerning education at a time and in a form to be of largest service.

By reducing the size of the report from twenty-five hundred pages to somewhat more

than a thousand, chiefly through the condensation of statistical matter, and confining this matter to the second volume of the report, by a skilful selection of topics of wide contemporary interest and of avowed timely value, by simplifying and giving a scientific interpretation of the mass of statistical detail, and above all, by the very noticeable care with which the editorial supervision has been conducted, the report represents the accomplishment of a leadership that appreciates both the opportunities and the obstacles of the work of the bureau.

Commissioner Brown's general introduction in the first volume is a briefly expressed, yet comprehensive, survey of contemporaneous educational conditions and progress, not only in the United States but throughout the principal countries of the world. This, together with the first chapter, in which are given succinct discussions of the more significant educational events of the year, covering the widest range of topics—international educational relations, international congresses, educational commissions, educational boards and associations, teachers' colleges, national university, industrial education, school hygiene, high-school fraternities, teachers' pension funds, being among the important ones—are well worth the reading by every one who would be alive to the educational movements of the day. The classified summaries of state legislation relating to public education for the years 1906–1907 and 1907–1908 contained in the second chapter are invaluable indices of the character and direction of our educational progress. This chapter also contains a statement of the several enactments of the first session of the Sixtieth Congress which have a direct or indirect bearing on education.

The remainder of the first volume of the report is given over to the usual presentation of the more important items of the educational affairs in Porto Rico, Philippines, South America, Great Britain and Ireland, France and central Europe. In these days of comparative study, these chapters will have great value, not only for the student, but for the publicist as well.

Decidedly the most important and most welcome reform of which the 1908 report bears evidence has to do with the statistics of education—the reef upon which many a good official report ship has been wrecked. This reform was begun in the preceding report under the direct supervision of Professor E. L. Thorndike, of the Teachers College, Columbia University. Not only in the present report have the tables of statistical items been rearranged and effectively condensed, but an excellent interpretative summary accompanied by appropriate frequency curves has been prepared by Professor G. D. Strayer, of the Teachers College, Columbia University. Commissioner Brown has effected a much-needed change in the matter of the statistical work of the bureau, and while yet our educational statistics are not as complete or as intelligible as they need to be, this last report exhibits the longest stride of progress yet made.

Were perchance awards of merit made for prodigality of publication and distribution, for ponderousness of bulk and content and for procrastination of presentation, such would, without doubt by common consent go to the generality of annual reports of governmental departments and bureaus. To this generality there is at least one notable exception, and all workers in the field of education are glad to have this exception come from the United States Bureau of Education.

EDWARD C. ELLIOTT
UNIVERSITY OF WISCONSIN

THE MUSEUM EXHIBITIONS IN CONNECTION WITH THE HUDSON-FULTON CELEBRATION

IN an article published in the *North American Review* seven years ago,[1] the writer prophesied that, if the various museums and institutions in the city of New York could be induced to combine their efforts, a series of exhibitions might be presented which would constitute a most valuable addition to a Hudson-Fulton Celebration. About one year ago the trustees authorized the president of the Hudson-Fulton Commission to appoint com-

[1] "On Expositions and their Uses," *North American Review*, September, 1902.

mittees to take up museum work. He appointed the following committees:

Art and Historical Exhibits Committee.—Mr. J. Pierpont Morgan, general chairman.

Sub-committee in Charge of Scientific and Historical Exhibits.—Dr. George F. Kunz, chairman, 401 Fifth Avenue, New York; Mr. Samuel V. Hoffman, Mr. Archer M. Huntington, Professor Henry Fairfield Osborn, Mr. Philip T. Dodge.

Sub-committee in Charge of Art Exhibits.—Hon. Robt. W. de Forest, chairman, Metropolitan Museum of Art; Sir Caspar Purdon Clarke, Dr. Edward Robinson, Mr. George F. Hearn, Dr. George F. Kunz.

When the Art and Historical Committee was formed, the writer accepted the chairmanship of the sub-committee on Scientific and Historical Exhibits, and in cooperation with the members of this sub-committee and those of the sub-committee on Art Exhibits, was successful in realizing a most gratifying result. The ready response to requests for suitable exhibits has indicated the general interest aroused by the celebration.

The special exhibits noted in the following list have been carefully selected to emphasize the essential character of the occasion, so that they may give to the visiting thousands a more immediate and intimate knowledge of the conditions obtaining in Henry Hudson's time, and of the initiation and development of steam navigation, than could be secured by the study of the text-books and histories that treat of these matters. They will be glorious object lessons and will serve to arouse a feeling of civic pride in our citizens, and also to impress those who come from all parts of our land with the greatness and historic importance of our metropolis, and will powerfully stimulate the taste for art, science and history.

May this grand celebration, in all its various forms and phases, help to arouse, not only civic pride, but also civic virtue, so that the future progress of our city in material greatness and spiritual worth may testify to the permanent effects produced by it.

The following carefully prepared list of museums and institutions, with the time, place and duration of the free exhibitions, may be of value, as a reference, to the scientists, and we herewith append them.

American Museum of Natural History, Seventy-seventh Street, from Columbus Avenue to Central Park West. Open daily, except Sundays, from 9 A.M. to 5 P.M.; Sundays from 1 to 5 P.M. Always free. Special exhibition during the Hudson-Fulton Celebration, from September 1 to December 1. Original objects showing the life and habits of the Indians of Manhattan Island and the Hudson River Valley. (Special illustrated guide for sale, price, ten cents.)

American Society of Mechanical Engineers, Engineering Building, 29 West Thirty-ninth Street. Robert Fulton exhibition, consisting of paintings, drawings, books, decorations and furniture, and working models of John Fitch's steamboat, the first boat operated and propelled by steam, Robert Fulton's *Clermont*, the first successful application of steam to navigation, and John Stevens's *Phœnix*, the first steamboat to sail on the ocean. The exhibition will be shown in the council room of the society, on the eleventh floor, and will be open from 9 A.M. until 5:30 P.M. during the entire period of the Hudson-Fulton Celebration, and from 9 A.M. until 5 P.M. daily until December 6.

Brooklyn Institute, Eastern Parkway. Open daily, except Sundays, from 9 A.M. to 6 P.M.; Sundays from 2 to 6 P.M.; Thursday evenings from 7:30 to 9:30 P.M. Free except on Mondays and Tuesdays, when admission fee is charged of twenty-five cents for adults and ten cents for children under six years of age. Collections illustrating various departments of archeology, mineralogy and ethnography. Special exhibition relating to past and present life of Indians on Long Island. Portrait of Robert Fulton painted by himself, the property of Col. Henry T. Chapman and loaned by him to the museum. Open September 1 to December 31. (Illustrated catalogue for sale.)

Children's Museum (Brooklyn Institute), Bedford Park, Brooklyn Avenue. Collection illustrative of the fauna of Long Island. Open free to the public from Monday to Saturday (inclusive) from 9 A.M. to 5:30 P.M., and on Sunday from 2 until 5:30 P.M.

City History Club of New York, 21 West Forty-fourth Street. Special exhibition of illustrations, photographs, maps and plans relating to the history of the city of New York, and all of the originals used in the City History Club Historical Guide Book of the City of New York.

College of the City of New York, St. Nicholas Avenue and 139th Street. Hudson-Fulton exhibit. During the Hudson-Fulton Celebration and for some weeks thereafter, the College of the City of New York will have on exhibition in its historical museum a collection of charts, views, manuscripts and relics representing old New York. Among the charts will be original prints of New Netherlands and New Amsterdam by Nicholas J. Vischer, about 1650; N. Visscher, 1690; Lotter's "New Jorck," 1720; contemporary plans and views of the revolutionary period showing the movements of Washington and Howe in this vicinity during the campaign of 1776; revolutionary battle relics; portraits, residences and letters of old New Yorkers; bronze busts of Washington, Lincoln and Fulton by Houden and Volk; and other material suggested by the celebration.

Department of Parks, Boroughs of Brooklyn and Queens. Through the courtesy of Commissioner Michael J. Kennedy, the different species of trees have been labeled in Prospect Park, from the Plaza to the Willink entrance; in Bedford Park; in Highland Park, and in Tompkins Park. An additional small enameled sign has been hung on those labeled trees that were indigenous to the Hudson River Valley in 1609. The special label reads: "This species is a native of the Hudson River Valley."

Fraunces Tavern, 54 Pearl Street, near Broad Street. Historic revolutionary building. Built in 1719. Scene of Washington's farewell to his officers on December 4, 1783. Restored December 4, 1907, by the New York Society of the Sons of the Revolution. Open daily, except Sundays, from 9 A.M. to 6 P.M. Special exhibition of revolutionary relics by the New York State Society of the Sons of the Revolution, who are the owners of the historic building, September 15 to November 1.

Long Island Historical Society, corner of Pierrepont and Clinton Streets, Brooklyn, between Brooklyn Bridge and Borough Hall. Open daily, except Sundays, from 8:30 A.M. to 6 P.M. Reference library of 70,000 volumes; manuscripts, relics, etc. Autograph receipt of Robert Fulton and original manuscript volume of Danker's and Sluyter's "Journal of a Voyage to New York in 1679–80."

Metropolitan Museum of Art, Central Park East. Main entrance on Fifth Avenue at Eighty-second Street. Open daily, except Sundays, from 10 A.M. to 6 P.M.; until December 31, to 5 P.M.; Saturdays to 10 P.M.; Sundays from 1 to 6 P.M. On Mondays and Fridays an admission fee of twenty-five cents is charged, except to members and copyists. Collections illustrating all departments of art and archeology. Special exhibition of a magnificent collection of over 130 of the works of seventeenth century Dutch masters, constituting the finest exhibition of this kind ever made. Products of colonial art: American paintings, furniture, pewter and silver of the seventeenth and eighteenth centuries, etc. (Two catalogues for sale, one of Dutch exhibit and one of colonial arts; price, ten cents each. Also finely illustrated edition de luxe.)

National Arts Club, Twentieth Street near Irving Place (Gramercy Park). This house was formerly the residence of Samuel J. Tilden, and is situated one block east of the birth-place of ex-President Roosevelt. Open daily from September 20 to about October 18, 1909, from 10 A.M. to 6 P.M. Special loan exhibition by the National Arts Club, in cooperation with the American Scenic and Historic Preservation Society. Three centuries of New York City: special exhibition of paintings, photographs, drawings and other interesting materials, illustrating the growth and progress of New York from the time of Henry Hudson to the present day.

New York Aquarium, in Battery Park. Under the management of the New York Zoological Society. Open daily, including Sundays, from 9 A.M. to 5 P.M. until October 15. (October 16 to April 14, from 10 A.M. to 4 P.M.) This building was erected in 1807 by the United States government as a fort and after the war of 1812 was called Castle Clinton; later, as Castle Garden, it was the scene of Jenny Lind's triumphs, and from 1855 to 1890 it was the portal of the New World for 7,690,606 immigrants. This is the largest aquarium in the world and contains a greater number of specimens and species than any other. All tanks containing fish indigenous to the Hudson River will be so marked.

New York Botanical Garden, Bronx Park. Museums open daily, including Sundays, from 10 A.M. to 5 P.M.; conservatories from 10 A.M. to 4 P.M. Grounds always open. In the grounds and conservatories exhibits of plants, shrubs, trees and natural woodland; in the museums, plant products utilized in the arts, sciences and industries. All trees growing on Manhattan Island and in the Hudson River Valley at the time of Hudson's arrival are marked with the letter "H." (Special illustrated catalogue for sale.)

New York Genealogical and Biographical Society, 226 West Fifty-eighth Street, between Broadway and Seventh Avenue. Open daily, ex-

cept Sundays, from 10 A.M. to 5 P.M., until November 1. Special exhibition of old deeds, manuscripts, books, portraits, etc., relating to the history of the United States up to and including the war of 1812. (Catalogue for sale.)

New York Historical Society, corner of Seventy-seventh Street and Central Park West. September 25 to October 30, open daily from 9 A.M. to 5 P.M. Robert Fulton exhibition of the New York Historical Society, in cooperation with the Colonial Dames of America. (Catalogue for sale.)

New York Public Library, Lenox Branch, Fifth Avenue and Seventy-second Street. Open daily, except Sundays, from 9 A.M. to 6 P.M. Special exhibition of prints, books, manuscripts, etc., relating to Henry Hudson, the Hudson River, Robert Fulton and steam navigation. (Special illustrated catalogue for sale; price, ten cents.)

New York Zoological Park, under the management of the New York Zoological Society, St. Nicholas Avenue (138th to 140th Streets), in Bronx Park. Open daily, including Sundays, from 9 A.M. until an hour before sunset (November 1 to May 1 from 10 A.M.). Free, except on Mondays and Thursdays, when an admission fee of twenty-five cents is charged. Exhibition of a splendid collection of animals, birds and reptiles. The fauna of Henry Hudson's time on Manhattan Island and in the Hudson River Valley will be indicated by the flag of the Hudson-Fulton Celebration. (Special illustrated catalogue for sale.)

Reformed Dutch Church. The Reformed Protestant Dutch Church of the City of New York will make an exhibit in the chapel of the church of St. Nicholas, Fifth Avenue and Forty-eighth Street, during the week of the celebration, 9 A.M. to 5 P.M. daily. (This church was organized A.D. 1628, and the exhibit will comprise articles connected with its long history.)

Van Cortlandt House Museum, in Van Cortlandt Park. This fine colonial mansion, built in 1748, with furniture of the period, is one of the oldest houses within the area of Greater New York; it is in the custody of the Colonial Dames of the State of New York. Open daily, 9 A.M. to 5 P.M. Special exhibition of mezzotint portraits of men prominent in political life prior to the revolution; Wedgwood's medallion portraits of illustrious personages; cartoons and caricatures of political events, etc. (Special illustrated catalogue on sale.)

Washington's Headquarters (*The Jumel Mansion*), Roger Morris Park, Edgecombe Road and One Hundred and Sixty-second Street. Built about 1760. Under the Department of Parks. Exhibition by the ladies of the Washington Headquarters Association, Daughters of the American Revolution. Open free daily, including Sundays, from 9 A.M. to 5 P.M. Special features: collection of colonial furnishings, objects and pictures; also the Bolton collection of war relics of the revolution.

American Geographical Society, 15 West Eighty-first Street. Special exhibition of books and maps relating to Henry Hudson and Robert Fulton. Admission can be obtained by card. Apply to the librarian, 15 West Eighty-first Street. Open from September 25 to October 9, from 9 A.M. to 5 P.M.

GEORGE F. KUNZ,
Chairman Historical and Scientific Exhibitions, Hudson-Fulton Celebration Commission, Tribune Building, New York

SCIENTIFIC NOTES AND NEWS

IN connection with the celebration of the twentieth anniversary of Clark University, honorary degrees have been conferred as follows: *Doctor of Laws*—Percival Lowell, Boston; Ernest Fox Nichols, president of Dartmouth College; William Fogg Osgood, Harvard University; James Pierpont, Yale University; Hermon Carey Bumpus, director of the American Museum of Natural History; Leo Burgerstein, University of Vienna; Carl Barus, Brown University; Franz Boas, Columbia University; Sigmund Freud, University of Vienna; Herbert Spencer Jennings, Johns Hopkins University; Carl G. Jung, University of Zurich; Adolf Meyer, Johns Hopkins University; L. William Stern, University of Breslau; Edward Burr Van Vleck, University of Wisconsin; Robert Williams Wood, Johns Hopkins University. *Doctor of Physics*—Vito Volterra, University of Rome; Albert Abraham Michelson, University of Chicago; Ernest Rutherford, University of Manchester, England. *Doctor of Letters*—Edward Bradford Titchener, Cornell University. *Doctor of Biology*—Charles Otis Whitman, University of Chicago. *Doctor of Mathematics*—Eliakim Hastings Moore, University of Chicago.

DR. HENRY FAIRFIELD OSBORN, of New York, has been elected a corresponding member of the Senckenberg Natural History Society at Frankfort.

AT the recent meeting of the Association of Edison Illuminating Companies, of New York City, a dinner was given to Mr. Thomas A. Edison. Among those who spoke were Mr. W. W. Freeman, the retiring president of the association, Mr. Thomas E. Murray, the incoming president, and Dr. Charles P. Steinmetz.

A LUNCHEON complimentary to Dr. Henry B. Ward, dean of the medical department of the University of Nebraska, was given by his colleagues at Omaha, on September 3, and, at the same time, the presentation of a gold watch was made to him. Dr. Ward, it will be remembered, has accepted the chair of zoology in the University of Illinois.

DR. MORITZ CANTOR, professor of mathematics at Heidelberg, has celebrated his eightieth birthday.

DR. OSCAR LENZ, professor of geography at Prague, has retired from active service.

PROFESSOR ALBRECHT PENCK, who lectured last winter at Columbia University, has returned to Berlin after visiting the Sandwich Islands and Japan.

PROFESSOR MORGAN BROOKS, of the electrical engineering department of the University of Illinois, has a year's leave of absence and will take a trip round the world, first spending about three months in Europe.

THE following members of the Bureau of Longitudes will represent France at the International Geodetical Congress which is to be held in London on the twenty-first inst.: General Bassot, president of the society, M. Henri Poincaré, M. Hanusse, director of hydrography in the French Ministry of Marine, M. Charles Lallemand, director-general of the French Ordinance Survey Department, and Colonel Bourgeois, chief of the surveying section of the geographical department of the War Office.

A. H. SUTHERLAND, Ph.D. (Chicago), has been appointed and has taken up his duties as assistant in psychology at the Government Hospital for the Insane, Washington.

IT is stated in *Economic Geology* that at the request of the Canadian Geological Survey for the loan of a topographer, the United States Geological Survey has granted R. H. Chapman leave of absence for one year and he is at present engaged in topographic work for the Canadian government.

MISS JULIA MCCORD, who has been assistant librarian of the United States Geological Survey for a number of years, has been made librarian.

DR. PAUL LANGHANS has become editor of *Petermann's Mitteilungen*, to succeed Dr. Supan, who has been called to the chair of geography at Breslau.

DR. HENRY C. CHAPMAN, professor emeritus in the Jefferson Medical College, Philadelphia, and known for his work in physiology, anatomy and medical jurisprudence, died at his summer home in Bar Harbor, on September 7, aged sixty-four years.

DR. RADCLIFFE CROCKER, of London, known for his contributions to dermatology, has died at the age of sixty-four years.

DR. KARL HABERMANN, professor in the Mining Academy at Leoben, died on August 20.

THE death is also announced of Dr. Valentino Cerrutti, professor of mathematics at the University of Rome.

THE autumn meeting of the American Physical Society will this year be held at Princeton University, on Saturday, October 23. This date has been chosen on account of the opening of the new Palmer Physical Laboratory, which will take place on the evening of October 22.

THE National Museum of Wales, of which Dr. W. E. Hoyle is director, at Cardiff, will have a new building to be erected at a cost of £250,000. It will include the following exhibition galleries: history and antiquities; geology and mineralogy; Welsh natural history; zoology and botany; industries; art; children's room; aquarium.

THE next International Congress of Mining, Metallurgy, Applied Mechanics and Practical Geology, will be held at Düsseldorf during the last week of June, 1910.

THE Missouri State Soil Survey and the United States Soil Survey have united on a plan of cooperative work. Each survey contributes $15,000 for the biennial period, 1909–11. Professor C. F. Marbut, director of the Missouri Survey has been appointed special agent in charge. He will also have charge of the reconnoissance work in the Ozark region of Missouri and Arkansas. The local detailed work and the selection of areas to be surveyed are largely decided by the state survey and the broader correlations and nomenclature are largely left to the United States Survey. The federal survey assumes the expenses of publication. Each soil party consists of one man from the United States Survey and one from the state survey. It is expected that from four to five counties will be surveyed each year.

SIR WILLIAM HARTLEY, of Liverpool and London, offers £1,000 to the first person who makes a successful flight in a heavier-than-air machine between Liverpool and Manchester. The aviator is to depart from within the boundary of Liverpool and land, without any intermediate stop, within the boundary of Manchester. The offer is international and will last for six months, the flight to be made between sunrise and sunset and twelve hours' notice to be given to the *Liverpool Daily Post and Mercury*, in whose hands the competition is placed.

THE government's work in poisoning prairie dogs on infested stock ranges in the Missoula National Forest district has had results this year which forest officers have decided warrant its continuation in 1910. For two years systematic efforts upon an extensive scale have been made by the Forest Service in cooperation with the stockmen, to rid the national forest ranges in Arizona, Colorado and New Mexico of these pests, but this work was not undertaken in the northwest until the spring of 1909. Eastern Montana and the Dakotas seem to be the worst-infested portion of the Missoula district. The national forest areas of these regions are comparatively small, but in some instances the colonies or towns of these animals cover an area of several hundred acres and the native forage plants have been greatly injured, while some range areas outside the forests have been practically devastated. In the spring of the present year small allotments of funds were made to the supervisors of the Custer and Sioux National Forests for the purpose of starting this work. The funds were for the most part expended in purchasing strychnine and other drugs used in preparing grain for bait, while the grain was furnished by the settlers. The poisoned grain, usually wheat, was distributed at the holes throughout the dog towns, both by forest officers and by forest users. More time was consumed in perfecting the plan of cooperation than had been anticipated and much of the bait was put out too late to obtain the best results, though several large dog towns were entirely cleaned up. Experience has proved that the grain should be put out very early in the spring for the best results may be obtained before green grass becomes available.

UNIVERSITY AND EDUCATIONAL NEWS

THE five hundredth anniversary of St. Andrews University will take place in 1913. At a recent meeting it was agreed to arrange for a national as well as an academic celebration. It has been resolved to form a general committee representing Scottish interests and sympathies, to fix the date of the celebration, and to endeavor to associate with the festival some permanent memorial of the anniversary.

THE number of foreign students at the German universities last summer was 3,921. The number includes 1,578 Russians, 674 Austro-Hungarians, 306 Swiss, 155 English, 154 Bulgarians, 102 Rumanians, 68 Servians, 60 French, 298 Americans, 175 Asiatics and 4 Australians.

FIVE scholarships and two fellowships have been awarded by the College of Agriculture of the University of Wisconsin. The two fellowships of $400 each recently provided by the regents were awarded to Alvin C. Oosterhuis, Sheboygan Falls, Wis., in animal husbandry, and Morris W. Richards, Madison, Wis., in horticulture.

DR. M. J. M. HILL, F.R.S., professor of mathematics in the University College, has been elected vice-chancellor of the University of London for 1909–10.

DR. WALTER MURRAY, of the University of Dalhousie, Halifax, has been elected president of the new University of Saskatchewan, established at Saskatoon.

DR. ALLEN J. SMITH, professor of pathology, has been appointed dean of the medical department of the University of Pennsylvania, to succeed Dr. Charles H. Frazer.

THE *Journal* of the American Medical Association states that Dr. H. McE. Knower, of the anatomical department of the Johns Hopkins University, has accepted a call to the University of Toronto, and Dr. Robert Retzer, of the same department, a call to the University of Minnesota.

DR. JOHN C. SHEDD has accepted the chair of physics in Olivet College.

DR. IRVING KING, who has been assistant professor in education at the University of Michigan for the past two years, has been called to the department of education in the State University of Iowa.

MESSRS. W. F. STEVE and PAUL DIKE have been appointed instructors in physics, and Messrs. Rufus A. Barnes and James Curry have been appointed instructors in chemistry in the University of Wisconsin.

THE following promotions and appointments have been made at Northwestern University: Dr. David Raymond Curtiss has been advanced from an associate professorship in mathematics to a full professorship. Dr. Robert R. Tatnall from associate professor of physics to professor of physics; Robert E. Wilson from instructor in mathematics to assistant professor in mathematics; Dr. Eugene H. Harper from instructor in zoology to assistant professor of zoology; Dr. James Caddell Morehead from instructor in mathematics to assistant professor of mathematics; Dr. Robert H. Gault has been appointed instructor in psychology; Dr. Charles S. Mead instructor in zoology, and Dr. Leigh Hunt Pennington instructor in botany.

DR. THOMAS H. BRYCE, lecturer in anatomy in the University of Glasgow, has been appointed to be regius professor of anatomy in succession to Professor John Cleland.

DR. JOHN MARNOCH, lecturer on clinical surgery at the Aberdeen Royal Infirmary, has been appointed regius professor of surgery in the University of Aberdeen in succession to Professor Alexander Ogston.

M. BOREL has been appointed professor of the theory of functions at the University of Paris.

DISCUSSION AND CORRESPONDENCE

GENERA WITHOUT SPECIES

IN his communication on this subject published recently in SCIENCE,[1] Mr. Caudell renders it clear that my reference[2] to certain correspondents cited by Professor Cockerell in a previous issue of SCIENCE[3] as being either ignorant or inexperienced in some of the more difficult questions in nomenclature was not without warrant, at least in the case of one of the persons mentioned by Professor Cockerell. Inasmuch as Mr. Caudell, in his reply to my communication, has misrepresented (apparently unconsciously) my position in the case, I beg space for a few words more on the general subject of genera without species and other matters incidental thereto.

The logical inference from the general tenor of his article is that I am opposed to the International Code of Nomenclature, and would allow personal opinion to intervene in opposition to its rulings. On the contrary, I have been not only loyal to the International Code in all its bearings but have, in various papers published during the last two years, strenuously advocated its acceptance as *the* definitive code, in so far as its rulings meet the cases that are constantly arising in zoological nomenclature. Furthermore, where cases arise that are not clearly covered by the code I have urged that such cases be referred to the Nomenclature Committee of the International

[1] Vol. XXX., pp. 210, 211, August 13, 1909.

[2] SCIENCE, Vol. XXIX., pp. 934–936, June 11, 1909.

[3] Vol. XXIX., pp. 813, 814, May 21, 1909.

Zoological Congress for arbitration, and that its decision be accepted as final. Still further, I have already submitted a number of such questions to this committee for decision, and stand ready to accept its decision of them, even should it chance to be adverse to my own personal views in the matter. This should answer Mr. Caudell's assumption, or at least insinuation, that I "hold that personal judgment should enter into the solving of this important problem" of genera without species, and that I am committed to "methods where personal opinion is given full sway." The tendency shown in frequent articles in SCIENCE and in various other scientific journals[4] to refer difficult questions in zoological nomenclature to a committee of arbitration, whose decision, right or wrong, shall be final, I consider one of the most hopeful signs for the future in the nomenclatural field.

To come now to the particular question under discussion, namely, genera without species. In my former paper on this subject I claimed that each so-called speciesless genus should be considered by itself, on its own merits. As said before, it was considered the correct thing, a century ago, for a systematist to publish a synopsis of a class of animals, giving merely diagnoses of the generic and higher groups; at least many such synopses were published, and were then held in favorable estimation. Most of the genera in such cases had been already established by previous authors and stand, of course, on the basis furnished them by their founders, and had originally one or more species referred to them, but of course were without designated types. In these systematic synopses some new genera were proposed, which, if not homonyms, and were not given preoccupied names, have been accepted and long since became part of the established nomenclature of systematic zoology. There were not, however, full-fledged and properly habilitated genera, from the modern view-point, until the necessity for genotypes became recognized and types for them had been duly designated.

[4] See especially Dr. W. H. Dall's "A Nomenclatural Court?" SCIENCE, Vol. XXX., pp. 147-149, July 30, 1909; and Dr. F. A. Bather, in *Ann. and Mag. Nat. Hist.* (8), Vol. IV., p. 41, July, 1909.

Apparently Mr. Caudell does not see anything very absurd in recognizing an ornithological genus based on an unmentioned three-toed woodpecker, but thinks the case would be quite different with a genus based on an unmentioned species of hymenopterous or dipterous insect with a particular kind of forking of a wing-vein. I agree with him perfectly on both these points, for in the one case the species on which the genus was based is identifiable and in the other it is not. I am perfectly well aware that there are hundreds of speciesless genera that are absolutely unidentifiable, and that they are especially the bane of entomology. In every instance they should be rejected; but they can not be wholly ignored, since, as they are not *nomina nuda*, the name given them is preoccupied for further use in zoology.

The whole question of genera without species is badly muddled by bringing into it irrelevant matters. It is not difficult to decide what named groups are entitled, from the standpoint of the author who proposed them, to be regarded as "genera" (and in this connection subgenera must come into the same category), or have been recognized as genera in literature. The only point is whether they are good genera or bad genera—in other words, whether they are identifiable or unidentifiable from the basis furnished by the original founder. Of course there may be differences of opinion as to whether or not a certain genus is identifiable; but this is a question of zoology and not of nomenclature, although the result of any decision on the point will necessarily affect nomenclature. The simile of "a family of Smiths without a John or a Jane in it," or "a name Johnson before any one was born to bear it," is, to my mind, wholly beside the case; as is also Mr. Caudell's assumption that "a genus without a species has no object; it is a name applied to a conception, not to an object, and can therefore have no place in systematic nomenclature." This, it strikes me, is *reductio ad absurdum*. Identifiable genera without spe-

cies are based on previously known species whose characters are, in part at least, recognizably expressed in the diagnosis of the genus. When they are not, such genera have no basis and must necessarily be considered as non-existent.

J. A. Allen

American Museum of Natural History

THE HYPOTHESIS OF "PRESENCE AND ABSENCE" IN MENDELIAN INHERITANCE

In our last report we gave reasons for regarding the rose-comb as a comb on which an additional element "roseness" has been superposed, and we suggested that the allelomorphic pair consists in the two states: presence of the factor for rose (R) and absence of that factor (r). The rose-comb is in reality a single comb modified by the presence of a "rose" factor. The same considerations apply to the pea-comb, which is single comb plus a pea-factor.[1]

There are reasons for regarding man as a chimpanzee on which an additional element, "manness," has been superposed. There you have man expressed or explained[2] in terms of his anthropoid ancestor. The characters of a frog are undoubtedly latent in the frog's tadpole. What is to hinder, therefore, expressing or explaining the frog in terms of the tadpole by saying the tadpole carries the characters of the frog? The logic is sound in the statement that the tadpole contains "frog factors" or "frogness." The question is merely as to the helpfulness of sound logic used that way.

This seems like the method of reasoning that, as somewhere remarked by Professor William James, would enable Hegel and his followers to successfully support the hypothesis that men are always naked—under their clothes.

I am not ailing with metaphysico-phobia. Quite the contrary: upon occasion I enjoy and can profit by a half-holiday in some cool, shady dell of the land of metaphysics. I recognize, nevertheless, that as a rule it is a misfortune for metaphysics to get mixed with objective science. I recognize further that however unfortunate the mixture may be at its worst when deliberately made, by far the most unfortunate is such a mixture when made all unconsciously on the part of the mixers.

The opening sentence of Huxley's essay "Scientific and Pseudo-scientific Realism" is this:

> Next to undue precipitation in anticipating the results of pending investigations, the intellectual sin which is commonest and most hurtful to those who devote themselves to the increase of knowledge is the omission to profit by the experience of their predecessors recorded in the history of science and philosophy.

Were the distinguished fellow of the Royal Society who wrote these lines living now, and were he a member of that society's evolution committee, he would, suiting action to word, almost certainly have saved his fellow committeemen the labor of discovering that the "allelomorphic pair consists in the two states, presence of the factor for rose (R) and absence of that factor (r)," by referring them to Hegel's "Logic," wherein the "divine principle" of Negativität is so fully and clearly set forth that its applicability to such cases as this becomes unmistakable.

> Difference implicit or in itself is a difference of the essence, and includes both the *positive* and the *negative*, and in this way: The positive is in the identical connection with self in such a way as not to be the negative, and the negative is the difference by itself so as not to be the positive. Thus either is on its own account, in proportion as it is not the other.[3]

Again:

> The foundation of all determinateness is negation (as Spinoza says, *Omnis determinatio est negatio*). Opinion, with its usual want of thought, believes that specific things are positive throughout, and retains them fast under the form of being. Mere being however is not the end of

[1] "Experimental Studies in the Physiology of Heredity," by W. Bateson, Miss Saunders and R. C. Punnett in "Reports to the Evolution Committee of the Royal Society," Report IV., 1908.

[2] A few scholastics, more Abelard-like than the generality in keenness of dialectic, point out that there is an important distinction between "expressing" and "explaining" modern phenomena such as these.

[3] "The Doctrine of Essence," in "The Logic of Hegel," translated by William Wallace.

the matter—it is, as we have already seen, utter emptiness and instability besides.[4]

Thus supplementing the Report of the Evolution Committee of the Royal Society with Hegel's "Doctrine of Being," it becomes clear at once why biology has so long failed to recognize that rose-comb is single comb plus "roseness." It is because "opinion, with its usual want of thought" has failed to perceive that ordinary comb (an instance of "mere being") is "utter emptiness and instability."

So logic scores again!

W. E. RITTER

LA JOLLA, CALIFORNIA,
August 11, 1909

SCIENTIFIC BOOKS

PAPERS FROM THE TORTUGAS LABORATORY

THE Carnegie Institution supports three laboratories devoted to biological research, the Desert Laboratory in Arizona, the Station for Evolution on Long Island, N. Y., and the Tortugas Station at the mouth of the Gulf of Mexico, all of which are maintained in the most liberal manner. The Tortugas Laboratory is due to the energy of the present director, Dr. A. G. Mayer, who examined many points in our warmer waters in his endeavors to find the best locality for the study of tropical marine life, and at last decided on the Dry Tortugas, not far from Key West. Each summer he has taken a number of investigators with him and has supplied them with every facility for work. These two volumes[1] of 516 pages, 84 plates and numerous cuts are the results of two seasons' work.

A review of such volumes is difficult. Adequately to criticize the separate papers is not the task of any one person, so varied is their scope. All that can be attempted here is a brief summary of their contents. For this purpose the nineteen papers may be grouped under separate headings.

Four articles, all in the second volume, deal with animal behavior and can not easily be summarized. Dr. R. P. Cowles describes the habits and reactions of the sand crab, *Ocypoda,* and Dr. Charles R. Stockard has a similar paper on the walking-stick, *Aplopus.* John B. Watson studied the habits of two of the terns, while Frank M. Chapman discusses the habits of the booby and the frigate bird.

In Professor Reighard's paper on the colors and habits of coral-reef fishes, which, as is well known, are frequently conspicuously colored, it is pointed out that the theory of warning colors usually advanced does not account for all the facts observed and a theory of immunity coloration is proposed as a substitute, which is defined as follows:

> Coloration, not sexually dimorphic, which renders an organism in its natural environment conspicuous to vertebrates; which has no selective value, since it does not aid the organism in escaping vertebrate enemies by concealment (protective coloration), nor in approaching its accustomed invertebrate prey (aggressive coloration), and when associated with disagreeable qualities is unnecessary as a warning to vertebrate foes of the existence of such qualities (warning coloration); it is conceived to have arisen through internal forces under immunity of the organism from the action of selection on its color characters.

In the first volume Dr. Mayer presents a study of pulsation of medusæ, in which he concludes that the stimulation of pulsation is caused by the formation of sodium oxalate in the marginal sense organs. This reacts on the calcium salts, precipitating calcium oxalate and setting free sulphate and chloride of sodium which act as nerve stimulants. Especially interesting is the way in which a pulsation once started in a ring cut from the medusan tissue may be made to continue in a circular course for days without further stimulation.

Dr. Mayer also returns to his discussion of the Floridan palolo worm, *Eunice fucata,* which at regular dates casts off the hinder sexual part of the body, these amputated portions swarming at the surface in vast numbers. From observations extending over several years, he points out that this occurs commonly within three days of the last quar-

[4] "The Doctrine of Being," *ibid.*

[1] "Papers from the Tortugas Laboratory of the Carnegie Institution of Washington," Volume I., 1908; Volume II., 1908.

ter of the moon which comes in the period between June 29 and July 28.

Four papers are more or less embryological. The late Professor Brooks and Mr. Kellner have a few notes on the embryology of *Oikopleura,* which are of especial interest because of our slight knowledge of the development of the appendicularians. Both eggs and embryos were found attached to the tails of the adults. Brooks and McGlone studied the development of the lung of the snail, *Ampullaria,* and find that gill, lung and osphradium are developed from a ridge in the mantle cavity, forming a series of homologous organs, differentiated for different functions. The lung becomes functional some time before the gill, as young individuals are easily drowned.

Professor E. G. Conklin traces the development of the medusa, *Linerges,* up to the gastrula stage and the free-swimming planula. The sudden appearance of large swarms of the medusæ seems to be connected with reproduction. The medusæ as rapidly disappear, sinking to the bottom and degenerating after depositing the eggs. Dr. Conklin also describes two peculiar actinian larvæ which are assigned to Van Beneden's provisional genera *Zoanthella* (Semper's larva) and *Zoanthina.* The description covers the morphology and histology. All attempts to rear the larvæ to adult conditions were in vain, so that exact relationships are unknown.

Dr. H. E. Jordan has three cytological papers in the first volume. The studies on the spermatogenesis of *Aplopus* seem in the main to be confirmative of the results of Wilson on other forms. Both of the other papers are based upon echinoderms and apparently are part of an attack upon the problem of the continuity of the chromosomes. In *Echinaster* the chromosomes are derived exclusively from the nucleolus, in *Asterias* partly from the nucleolus, and in *Ophiocoma* exclusively from the nuclear reticulum. These results are reconciled by a study of the nuclear constituents which leads to the conclusion that the chromosomes arise from any part that contains chromatin. At least in some forms his studies show little to confirm the idea of chromosome continuity.

The systematic papers are all in the first volume. A paper on the tunicates of the Gulf Stream is divided into sections. In the first Dr. Brooks redescribes both solitary and chain forms of *Salpa floridana.* In the second he presents renewed studies on the muscles of *Cyclosalpa,* reiterating his opinion that the ordinary distinctions in the text-books between the Cyclomyaria and the Hemimyaria are based on erroneous observations. The third section, by Brooks and Kellner, describes a new appendicularian, *Oikopleura tortugenesis.* A parasitic protozoan is described as *Gromia appendiculariæ,* which occurred attached to the tails of the tunicates, but it clearly does not belong to the genus to which it is assigned.

Dr. H. F. Perkins has a paper on the medusæ, describing several new species, with notes on others. It is interesting that not a single male *Cassiopea* was found. Dr. E. S. Linton notes the presence of 29 species of cestode parasites of fishes, several of which, including a genus *Pediobothrium,* are supposed to be new. C. H. Edmondson describes a new variety of Flagellata from the salt water of the moat around Ft. Jefferson.

J. S. KINGSLEY

The Green Algæ of North America. By FRANK SHIPLEY COLLINS. Pp. 480, 18 plates containing 160 figures. Tufts College Studies, Vol. II., No. 3, July, 1909.

This synopsis is certain to find a ready welcome among all botanists who deal with the green algæ either in class work or with more special interests. Among the algæ there has been no group in greater need of comprehensive systematic treatment than that of the Chlorophyceæ. A descriptive work on the fresh-water forms has been especially desired since these are more numerous and more extensively studied as plant types than are the marine species. Moreover, such general accounts of the fresh-water green algæ as have heretofore been published have not treated the taxonomic side with the fulness and accuracy demanded by the difficulties of the subject. Mr. Collins must feel great satisfaction in bringing to such a fruition the results of

many years of study, and Tufts College is much to be congratulated on the way in which it has availed itself of the privilege of publication.

The work describes all the species of green algæ, exclusive of the desmids and stoneworts, known to occur in North America from Greenland to the West Indies and Mexico. The characters of each genus (with the exception of four) are illustrated by figures of at least one species. The figures, taken for the most part from authoritative sources, are well executed and will greatly assist the general student to a clear understanding of generic characters. An extensive bibliography is presented. The index is very full, including not only the species and synonyms, but also structural and descriptive terms with references to the pages in the text on which they are defined, so that the index thus serves the purpose of a glossary.

The descriptions of species are clear and concise and include a reference to the original publication of the binomial, to some good plate or figure, and when possible to some set of exsiccatæ, and conclude with records of American localities to which are added the distributions in other parts of the world. The Phycotheca Boreali-Americana of Collins, Holden and Setchell is naturally most frequently cited among the exsiccatæ as the one most accessible for American students and richest in American species. Mr. Collins as chief editor of this set of algæ has had exceptional opportunities to handle large quantities of material and probably much of his work bestowed on this exsiccata finds further and fuller expression in this book. A considerable number of American botanists will recognize that through their contributions to the Phycotheca and in other ways they have had a small share in making possible this account.

The best test of the general value of such a work as this will be its usefulness in the hands of those who are not algologists. This usefulness will depend very largely on the accuracy and at the same time the simplicity of the analytical keys. Good keys are necessarily based on the more obvious characters which are not always the most important systematically, and perhaps nowhere in works of this character can greater care be shown or is greater judgment required than in the construction of these more or less artificial guides. Genera such as *Spirogyra* with 38 species in this account, *Œdogonium* with 74 species and *Cladophora* with 53 species, illustrate the great difficulties. In some cases Mr. Collins has been able to make use of keys in certain monographs, as for example Hirn's detailed account of the Œdogoniaceæ, but for the most part they are the result of his own studies and ingenuity. His skill in this sort of work has already been shown in the admirable accounts of the Ulvaceæ, Cladophoras, etc., published at various times in *Rhodora*. The keys of this manual possess the characteristics of clearness and simplicity shown in his former work. Besides the keys to species there are also keys to the genera, families and orders, so that the synopsis is well planned in respect to all the aids that enable the reader to handle the text quickly and without confusion.

A brief account of the general system of classification is presented at the end of the introduction, but so closely associated with other matter that the attention of the reader is not brought quickly to its notice as might have been the case had the account been given a separate heading, which its importance fully justifies. Mr. Collins is not willing to follow to the extreme those arrangements which group the green algæ in large subdivisions or classes according to the structure of the reproductive elements and especially the ciliated reproductive cells, and in this respect he takes a conservative attitude. Only one group is split off from the main assemblage of the Chlorophyceæ—the Heterokontæ, a small class the forms of which are of uncertain relationship. It seems even doubtful to the reviewer whether this group (Heterokontæ) is worthy of such distinction, and there is much to be said in favor of applying the name Chlorophyceæ in its broadest signification with the full understanding that it embraces a number of distinct phyla. It is certainly hardly less broad with such divergent groups as the Conjugales, Volvocales, Ulothrichales, Siphonales,

etc., than with the Heterokontæ also included. However interesting and important are the speculations regarding the derivation of a number of lines of green algæ from a flagellate ancestry, we have not as yet such knowledge of the cytology of the reproductive cells as to give a firm foundation for systems of classification based chiefly or wholly on their structure. The groupings of the orders and families follow in the main well-known arrangements and are easily understood.

The introduction contains various matters of interest, some of which might with advantage have been grouped under headings and perhaps given more extended treatment. There are historical comments, remarks on distribution, several pages devoted to a very practical description of methods of collecting and preserving algæ, references to literature helpful to the general student, and at the end the above-mentioned account of the system of classification.

As regards the form of the book, some suggestions occur to the reviewer which are here given with the thought that later editions will be called for and also in the hope that Mr. Collins will write similar synopses of other groups of algæ. Readers would greatly appreciate page headings giving the genus on the right-hand page and the family or order on the left instead of the repeated title and publication. The figures would have been more useful as illustrations if distributed as text figures throughout the book, associated with the genera that they illustrate, rather than collected in a series of plates at the end. These changes in form and arrangement, although increasing somewhat the cost of publication, would be especially appropriate to a taxonomic work and would certainly add to the effectiveness of this remarkably clear and simple treatment.

BRADLEY M. DAVIS

Handbook for Field Geologists. By C. W. HAYES, Chief Geologist, U. S. Geological Survey. New York, John Wiley & Sons. 1909.

It seems to be a trait of human nature not to wish to buy official reports and to ignore the value of material contained in the same. Advantage has been taken of this by certain prudent publishers who reprint the more interesting and widely important government reports, finding a ready sale therefor. A number of Dr. Merrill's valuable books are practically reprints of guides to national museum collections. The book before us is of this class, and the publishers are to be thanked for introducing so valuable a work to a wider circle. This is practically a reprint of the instructions to United States field geologists, and any one who has occasion to do any practical work in geology can not fail to find much in this small book (which he can easily slip into his pocket) which will be of help to him.

This origin explains a certain dogmatic character. There is no discussion of various methods or of dubious points, but one good method is given for solving various geological problems. In no other way could so much be packed into so small a space. The style is clear and simple and there is no one better qualified to prepare such a book than the author—the Chief Geologist of the U. S. Survey.

Most of us will, I think, in reading such a book, feel as we do in reading the Bible, that we have left undone things which we ought to have done and done things which we ought not to have done. In helping one to make the necessary observations, the second part, which includes a set of schedules of the observations which should be made in studying land forms, petrology, geological structure, glacial deposits, ores and various classes of economic materials, will be of great help and suggestiveness to any one who has occasion to make inquiry in these lines. One might, perhaps, ask whether the absence of any schedule with regard to water investigations implies that the hydrographers know nothing about geology or that the geologists have little use for water! The first part includes not only suggestions for the field geologist along every line, but helps to obey these suggestions, from unit rations to mathematical formulæ. It can be most highly recommended not merely to geologists and scientific men, but, as many of the

points are applicable to any camper-out, to any one who has to do with mining or civil engineering, and it should be brought to the attention of a wide circle.

Alfred C. Lane

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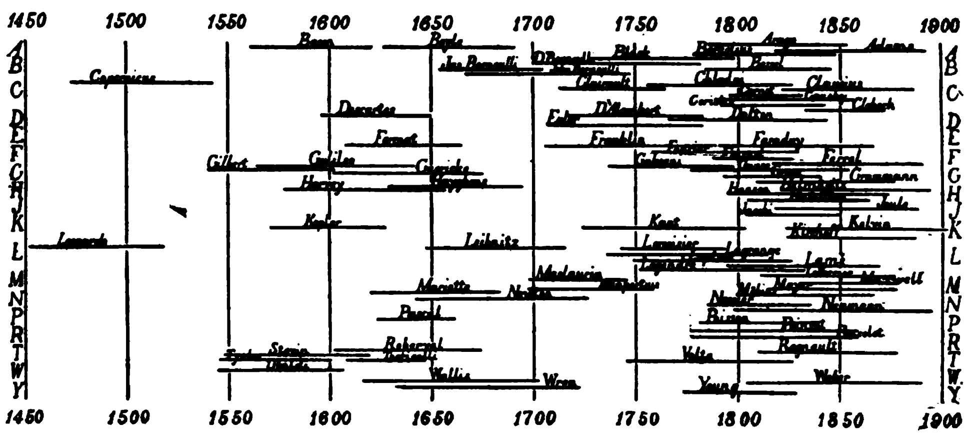
SCIENTIFIC JOURNAL

The Journal of Experimental Zoology, Vol. VI., No. 4 (July, 1909), contains the following contributions: "Factors of Form Regulation in *Harenactis attenuata*," by C. M. Child. The contraction of tissues following a wound does not appear to be an adaptive reaction to accomplish wound closure, but merely a physiological result of the injury to the tissues. The rapidity of oral restitution and to some extent the size of the parts decrease with increasing distance of the level of restitution from the original oral end, until in short proximal pieces restitution usually ceases with wound closure. "The Effects of Centrifugal Force upon the Eggs of some Chrysomelid Beetles," by R. W. Hegner. Eggs of five species of three genera of chrysomelid beetles were centrifuged at ages ranging from those freshly laid to those with well-developed blastoderms. Three strata were induced regardless of the orientation of the eggs in the centrifugal machine. In some cases eggs with their contents redistributed produced normal embryos or larvæ; in other cases a dwarf embryo resulted at the inner (light) end of the egg, not having grown around the yolk as in eggs developed normally. Female beetles after centrifuging laid eggs as usual; these with two exceptions produced normal larvæ. "Contributions to Experimental Entomology, I., *Junonia cœnia* Hübner; II., Two Cases of Anabiosis in *Actras selene* Hübner," by William Reiff. "Adaptation and Immunity of the Lower Organisms to Ethyl Alcohol," by J. Frank Daniel. The author studied the acclimatization of certain infusoria (*Stentor* and *Spirostomum*) to alcohol. Some strains of these animals showed a considerably increased resistance to alcohol after being kept for a few days in weak solutions of this substance. In other strains, having a high resistance to begin with, scarcely any increase of resistance could be caused by this means. The increase of resistance was limited to the substance used in acclimatizing the animals; when acclimatized to ethyl alcohol, they showed a decreased resistance to other chemicals.

HISTORICAL GRAPHICS

Some time ago, while preparing a paper on the history of physics, I adopted the plan of inserting the life interval of the great masters in metric cross-section paper, to the year. My only excuse for referring to the matter here is this method of reference, which proved itself surprisingly useful, both at that time and since. It consists in plotting straight line life periods chronologically, from left to right and the corresponding names alphabetically from top to bottom. Authors are thus easily found and the chronological comparison is im-



mediate. If hand charts are desirable it is expedient to reserve one chart for each of the great divisions of physics, dynamics, molecular physics, acoustics, heat, light and electricity. I attach such a chart of names bearing on the history of dynamics, in which the main coordinates only have been indicated, as the smaller divisions should be in a subordinate color. It shows, for instance, the dearth of interest in such subjects in the middle of the sixteenth century and toward the beginning of the seventeenth century, except on the part of a few men of irrepressible genius, as well as the terrific general onslaught which occurred with the beginning of the nineteenth century.

To make the chart more useful the chief date in each life should be indicated by a crossline (not shown), as for instance in case of Newton, the date of publication of the "Principia," of the "Optiks," etc.

I am writing this note with the hope that somebody will undertake the work seriously and with some degree of completeness. It seems to me clear that available wall diagrams of this kind would not only enliven the work of the teacher of a forbiddingly difficult subject, but would suggest the vast array of profound investigation to which the physics of the present day owes its assurance and trenchancy.

CARL BARUS

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SPECIAL ARTICLES

ON THE OCCURRENCE OF THE LITTORAL BARNACLE CHTHAMALUS STELLATUS (POLI) AT WOODS HOLE, MASS.

To one acquainted with the world-wide distribution of this barnacle, it would seem rather superfluous to call attention to its presence in any specific locality. It is a rather curious fact, however, that this abundant and almost cosmopolitan species seems to have hitherto escaped the notice of those who have listed the New England fauna. Neither Gould ("Invertebrate Animals of Massachusetts," 1840), nor Verrill ("Invertebrate Animals of Vineyard Sound," 1873), nor Miss Rathbun ("Fauna of New England: List of the Crustacea," 1905) have included this barnacle among the New England species, though certain far less common forms are listed by each of these writers; and the only reference of which I am aware to its occurrence on the Atlantic coast of North America is contained in Darwin's "Monograph of the Cirripedia," in which he refers to "some specimens attached to oysters sent to me by Professor Agassiz, from Charlestown" (p. 457). It would seem more than possible that *Charleston* is here intended, for on a previous page (456), Darwin includes "Southern United States (Charlestown)" among the localities from which *Chthamalus stellatus* is recorded. I am informed by Miss Rathbun that no specimens of this barnacle from New England are known to be contained in the U. S. National Museum collections. Through the kindness of the curator, Mr. C. W. Johnson, I have examined specimens of this species (varieties *communis* and *fragilis*), contained in the collections of the Boston Society of Natural History. The locality has not been recorded, however, and there is nothing to indicate whether or not the specimens came from New England waters.

The author was first led to look for this species at Woods Hole during the present summer, when he found it to occur in considerable numbers on Penzance Point, along the shore of Woods Hole passage. Further search has revealed its presence on the piles of piers at Woods Hole, New Bedford and Vineyard Haven, and on rocks at Nobska Point, Nonamesset Island, and the shore of Buzzards Bay near Woods Hole. It is probable, indeed, that its local distribution is very general. At the last named point this species seems to be particularly abundant. It extends considerably higher up on the boulders than does *Balanus balanoides,* with which, however, it is associated at a lower level. It thus occurs at points which must be uncovered by the tide for the greater part of the time. In local waters, so far as I have seen, *Chthamalus* never grows in such dense clusters as does *Balanus balanoides,* and indeed it appears unable to compete very successfully with the latter in its proper zone.

Like its associate, it is a strictly littoral form and probably does not extend below tidal limits.

Chthamalus stellatus was first described by Poli in 1795 from specimens taken on the coast of Sicily. It is so abundant on some parts of the French coast that Pruvot[1] recognizes a "Chthamalus zone" as one subdivision of the littoral zone. The same species is common upon the southern coast of England, being "in parts, even more numerous than the *Balanus balanoides*," according to Darwin. The other localities listed by Darwin include points as remote from one another as Ireland, China, Oregon, the Red Sea and the Rio Plata. Gruvel[2] likewise includes Iceland and Patagonia, so that the species may truly be regarded as cosmopolitan.

It is surely difficult to explain how this barnacle has been so long overlooked upon our own Atlantic shores. It is hard to believe that the present species has been habitually confused with *Balanus balanoides* by the long succession of field naturalists and systematic zoologists who have exploited the shores of New England for over a century. These men erred rather in the direction of discovering too many new species than in ignoring well-established ones. An alternative explanation is that *Chthamalus* has only recently invaded New England waters, just as we know that various other species have done within recent years. The mollusk *Litorina litorea* and the actinian *Sagartia luciæ* are doubtless the most striking local examples of this phenomenon, though we have strong evidence for a few other cases. From the comparatively small size of the local examples, and their unworn appearance, as compared with the older specimens of *Balanus balanoides,* the writer was at first tempted to think that the immigration had only reached local waters during the present season. He has, however, found a few specimens on stones which had been collected three years ago.

The local examples, in large part at least, seem to belong to the variety *"fragilis"* of Darwin, as did the specimens received by the latter author from "Charlestown" (=Charleston?). A characteristic of this variety is the smooth, delicate appearance of the valves, referred to above as distinguishing local specimens. At Woods Hole, I have found few having the rugosity, the weathered aspect, or even the whiteness of *Balanus balanoides*. Our local representatives of the species are so much darker in color and so much smoother in appearance than the associated *Balanus* as to be plainly distinguishable from the latter, even at considerable distance. Thus the confusion of the two, said to have been commonly made by English collectors, seems incredible here.[3] The largest specimens which I have seen have not exceeded 10 mm. in diameter at the base.

Not being a specialist in the difficult group of Cirripedia, I grant freely the possibility that I have made an error in my *specific* determination. The species in question is, however, a *Chthamalus* in any case, and *C. stellatus* is the only one hitherto listed from the North Atlantic. The interest of its discovery in local waters would not be lessened, but rather increased, if it were shown that we had to do with another member of the genus.

F. B. SUMNER

[1] *Archiv de Zoologie Experimentale et Générale,* Tome V., 1897.

[2] "Monographie des Cirrhipèdes," p. 201.

[3] Of course the two genera are distinguished by much more fundamental characters than mere appearance.

THE SEVENTH INTERNATIONAL CONGRESS OF APPLIED CHEMISTRY

THE Seventh International Congress of Applied Chemistry convened in the Great Albert Hall, London, on May 27 last under the patronage of the King of England.

The vice-patron, the Prince of Wales, accompanied by the Princess, presided. In opening the congress he spoke of the pleasure experienced by His Royal Highness, King Edward VII., in having the congress meet in London and his own appreciation of the significance of the passing of the "rule-of-thumb" period in modern civilization, the close relationship between science and commerce and the important bearing such conferences had in promoting the peace of the world. His remarks were greeted with cheers from the diplo-

matic representatives of the various governments at the Court of St. James, who formed a picturesque background for the royal patrons, and the hundreds of distinguished men of chemical science gathered around and in front from more than twenty of the civilized nations of the world.

Sir Henry Roscoe, the honorary president, offered an English welcome to his colleagues assembled from all parts of the world and thanked the royal patrons for the felicitous manner in which they had inaugurated the conference.

Sir William Ramsay, the acting president, welcomed the foreign representatives in the official languages of the congress, English, French, German and Italian. He emphasized the close relationship between pure and applied chemistry as observed upon the Continent, and the especial need of a fuller realization of the fact in Great Britain and America. He complimented the Italian organization committee of the sixth congress for applying the surplus of the funds to defraying the expenses of a band of Italian students in attendance on the London congress. He concluded his remarks by quoting the motto, "Philadelphia Manetol"—"Let brotherly love continue!"

These addresses of welcome were responded to significantly in complimentary terms in the following order:

Speaking for America Dr. H. W. Wiley (in "Ustatian") called attention to the fact that, but for what chemistry had done, teeming millions of our globe would be unclad and unfed; the principles of prophylaxis in medical science were mainly due to the services of chemistry; sanitation is applied chemistry; pure food, pure air, pure drink meant pure minds and bodies, prolongation of life and more effective endeavor; and more important than all, chemistry had elevated the morals of man by detecting and exposing fraud.

Professor Armand Gautier (in French) called attention to the rivalry—always friendly and not hostile—of the men of science in France and England, and that in spite of past differences due to political causes, the mutual appreciation of the men of science in the two countries had annihilated those differences and brought them in closer communion than possible through any formal treaties.

Professor Dr. O. N. Witt (in German) anticipated that the present congress would mark a further "advance in the path of international discussion and understanding trodden by our science" and every country was interested in some degree in the subjects of the congress.

Professor E. Patrnò (in Italian) referring to the enthusiasm shown in Rome to accept the invitation to hold the seventh congress in that country which produced Boyle, Black, Cavendish, Priestley, Wollaston, Dalton, Davy, Faraday and Graham. "Even in the busy, noisy, bewildering rush of London life men of science yet know how to find the tranquility and quiet necessary for the investigation and discussion of the most abstruse problems of philosophy and science."

Professor Arrhenius (in English), speaking for the other foreign countries, referred to England as the classical land of applied chemistry and of the application of improved hygiene in London so that it had the lowest death rate among the large cities of the world.

Sir Frederick Bridge, organist to Westminster Abbey, gave a preliminary organ recital and the national anthem was played and sung as the formal inaugural meeting concluded.

The congress was divided into seventeen sections. The titles of the papers presented are of interest, but are omitted on account of lack of space.

It may be remarked here that more or less confusion resulted in some instances when joint meetings of sections were announced. This should be avoided. It also appears to your representative that four days are too few for the best results from such a large congress. It was quite impossible to determine the exact hour at which many important papers were to be presented and only too frequently extremely interesting subjects, more or less allied, were under discussion in different sections.

The social features of the congress were undoubtedly of equal if not greater importance than the papers presented. The English homes were hospitably wide open. Numerous delightful private dinner parties, followed by more numerous receptions, charming garden parties such as only the English know how to give, gave every chance for intimate exchange of ideas. Of the private garden parties reference can only be made to one given by Dr. and Mrs. Ludwig Mond and Mr. Robert Mond on Sunday afternoon, May 30, to which 1,700 tickets were issued. These included the entire Italian delegation, which took advantage of the occasion to present Dr. Mond with a noble bronze in appreciation of his numerous gifts to the art and science of Rome. The garden party was not only complete in the most elaborate detail for the

varied entertainment on a suitable scale for the large company, but was arranged to display some of the exquisite ancient art recovered in Egyptian excavations, the expenses of which were borne by the Mond family. In the adjoining home of Mr. Robert Mond there was perhaps the best exhibition of colored photographs, many taken by him, in any private collection. One also saw there pure nickel and cobalt in various forms, and the various carbonyls of nickel, iron, cobalt and palladium, some shown the first time.

The American Ambassador, the Hon. Whitelaw Reid, gave a dinner to the American commissioners on Whit-Monday evening at Dorchester House, followed by a reception attended by over 1,000 members. Dr. Messel also entertained the American members at tea at the White Hart Hotel, after the visit to Windsor Castle, Wednesday afternoon.

The following general receptions were held:

May 26—Reception by the Lord Mayor and Corporation of the City of London at the Guildhall.

May 27—Reception at the Foreign Office.

May 29—Reception by the London Section of the Society of Chemical Industry at the University of London.

June 1—Reception at the Natural History Museum.

The London ladies' committee did everything for the comfort and pleasure of the visiting ladies. A charming garden party was given by them at the Botanic Gardens, to which the men were also invited. The season was just right for a magnificent display of rhododendrons and laurel.

On Friday evening, May 28, a joint banquet of the congress and the Society of Chemical Industry, which met in annual session the day before the congress convened, was held in the Crystal Palace. Sir William Ramsay, supported by Professor Raphael Meldola, retiring president of the Society of Chemical Industry, presided over the 1,500 ladies and gentlemen present.

The president proposed the toasts, "The King," "Foreign Rulers" and "Our Friends from Abroad." With the last he coupled the names of Nichols, Brauner, Gautier, von Böttinger, Piutti and Hoogewerff.[1]

Dr. Nichols, replying for America, said that he resided in New York, spent his summers in Canada, and was a representative of the Mexican government. As a commissioner of the United States government and the official representative of the American Chemical Society he thanked the hosts for their wonderful hospitality. While the chemist owed much to the world, the world owed much to the chemist and it would owe more before it owed less. In the great problems of the future just about to commence, the building up rather than the pulling down of the universe, the chemists of America would do their share.

Professor Bohnslav Brauner replied in English for the Austrian Imperial Monarchy. Thirty years ago he had studied under the distinguished honorary president, Sir Henry Roscoe, when he was preaching a crusade against the domination of the "rule of thumb" and he rejoiced that the highest in the land now declared that the "rule of thumb" was dead, and the Congress of Applied Chemistry was the one to give it its *coup de grâce*.

Professor Armand Gautier, speaking in French, said that the *entente cordiale* existing between the English and French chemists dated back to the period when Priestley went to Paris, when Lavoisier called Black his master and when Napoleon allowed Humphry Davy to travel in France with his assistant Faraday at a time when every Englishman was forbidden French soil.

Dr. von Böttinger trusted, in German and English, that the congress would not only further the work of science but the amiability and friendship among all nations.

After Professor Piutti had said a few words for Italy, Professor Hoogewerf, of Holland, spoke for the other nations, whose representatives were mentioned later in alphabetical order beginning with Argentina and ending with Turkey. Dr. Hoogewerff referred to the founding of the theory of ions by Faraday, Ramsay's discovery of the noble gases and the recent apparent demonstration of the disintegration of what was formerly regarded indivisible. The sulphuric acid industry had its birth not far from London, the first city to be lighted by coal gas, and the Scotchman, Young, laid the foundation of the shale industry and Perkin began the coal-tar industry.

An elaborate display of fireworks in the grounds of the palace closed the proceedings. Special trains conveyed all to and from the city.

On Saturday morning, May 29, the King rereceived a deputation from the congress accompanied by Sir Henry Roscoe, Sir William Ramsay and Mr. William Macnab (honorary general secretary). The following constituted the deputation: Dr. W. H. Nichols (America), K. K. Regier-

[1] The writer is indebted to the official stenographic reports of the Society of Chemical Industry for notes of these speeches.

ungsrat Fred. Strohmer (Austria), Dr. Francis Sachs (Belgium), Mr. Ou Kouanze (China), Professor Léon Lindet (France), Geh. Regierungsrat Professor Dr. Otto N. Witt (Germany), Professor Emanuel Paternò (Italy), Professor Kuhara (Japan), Dr. S. Hoogewerff (Netherlands), N. Tavildaroff (Russia), Professor Pinerûa y Alvarez (Spain), Professor Arrhenius (Sweden) and M. F. Reverdin (Switzerland).

Four general lectures were arranged in Great Hall of the Imperial Institute. Two short ones on Friday, May 28, were given by Professors Haller and Paternò. The writer was unable to attend these and has not secured either the titles or accounts of the lectures, hence he regrets he can not give abstracts.

On Monday, May 31, Professor Witt gave an admirable address in perfect English on "Evolution in Applied Chemistry." A complete appreciation of the charming lecture requires its perusal in the Transactions, which should appear within the year.

He said that evolution was no longer a working hypothesis in natural science; it had become a way of thinking. One of the best combinations of empiricism and theory was the examination of old empirical industrial processes by the methods and in the light of modern science. Much valuable information had been thus obtained, but what an immense amount of information still remained lying dormant in unread Egyptian papyri and palimpsests! There is a great treasure of industrial experience of the eastern nations, much of which is equal to or superior to that of the western peoples. We know so little about them, and what we do know is from accounts of travelers, who were not chemists. Industries which have benefited by secrets derived from the East are cotton-dyeing, calico-printing, indigo-dyeing and porcelain. A duty of such international congresses is to watch over the intellectual wealth of the past and to collect it before it disappears forever by the adoption of more rapid western methods.

The biological analogy of the influence of environment on the development of industries was dwelt upon. Whenever an industry left its native country, or often even when it moved from one part of a country to another, it had to be remodeled to suit the different conditions. The history of applied chemistry is filled with instances in which the survival of the fittest meant nothing more nor less than a victory for economy. As a whole, progressive economy was not so dependent upon improvement in apparatus as upon the simplification of the fundamental chemical reactions—in other words, upon better utilization of the energy involved.

Only recently have we begun to have a conscience for fuel. The quantity of fuel required to produce the energy for any industrial process was dependent upon the manner in which it was required to do its work. Once smoke was regarded as an evil, then a nuisance, now it is known as a waste, and none had better cause to wage war against it than he who produced it. A smoking chimney is a thief, not only because it carries visible unburned carbon into the atmosphere, but in a majority of cases invisible carbon monoxide and methane, with all the latent energy they contained. Regenerative gas-heating not only prevents smoke, but is a powerful means of economizing heat. The saving of national wealth effected by it might amount to a sum sufficient to pay the aggregate national debts of all the civilized nations. Uncivilized nations were blessed with neither national debts nor heat-regenerating appliances.

Professor Witt closed his lecture by reference to symbiosis and aggregation. As plants and animals of totally different nature and organization combine for joint life and activity with the object of self-protection in the great struggle for existence, so the various forms of chemical industry were essentially dependent upon each other for success and progress. The more varied and numerous the factories, in spite of apparent competition, the more they prospered. Congresses of chemists, such as the one in session in London, represent a modern form of human symbiotic effort. "They proclaimed the great truth that science knew no boundaries and frontiers, that it was the joint property of all humanity, and that its adherents were ready to flock together from all parts of the world for mutual help and progress."

On Tuesday afternoon, June 1, Sir Boverton Redwood gave a lecture upon "Liquid Fuel," which was rich in matter, suggestive, splendidly illustrated and excellently presented.

Upon the invention of the steam engine the days of the windmill and old-time water wheel seemed to be numbered; sailing ships had given way to mechanically-driven vessels; gas-explosion engines and electric power seemed to be driving out the horse, without whose aid at one time it was thought that no civilized nation could exist. In some directions there was a disposition to revert to the old order of things, as shown in the utilization of water powers with improved appli-

ances; inventors were not without hope of utilizing the ocean tides; in fact, several installations do exist where this is done. Some imaginative people held out in the indefinite hope of our securing some unknown form of energy, but dependence upon such an assumption was undoubtedly gratuitous folly. It was therefore of the utmost importance that the strictest economy be practised in the expenditure of our fuel capital and thus postpone a fuel famine, which is of the gravest importance to a country situated as England is. The principal fuels, in addition to wood, coal and petroleum, including natural gas and products obtained from destructive distillation of bituminous shales, are lignite, peat and alcohol.

Reference was made to President Roosevelt's important call for an international conference on the conservation of natural resources that an inventory of the world's supply might be prepared. Attention was directed in this connection to the report of Dr. D. T. Day, petroleum statistician of the U. S. Geological Survey, who has given data to show that at the present rate of increase America's supply of petroleum will be exhausted in 1935, and if the present output were maintained the supply would last only ninety years.

A review of the sources, geological and geographical, of petroleum showed that its distribution is wide, but the world is largely dependent at present upon the United States and Russia. The output could be greatly increased, because up to the present those deposits only which yielded oil suitable for conversion by fractional distillation into lamp oil and the ordinary commercial products of the refinery had been utilized. Now with the more general development of the use of oil for fuels, the heavy forms of oil have become marketable products. In this connection attention was directed to the ease now experienced in pumping the most viscous oils through pipes, which was formerly regarded impossible, by rifling the pipes and lubricating them with a current of water, which travels simultaneously through the grooves.

In this connection it was stated that for most purposes on land the internal combustion engine would before long replace the steam engine, at least for moderate powers. The steam engine furnishes only about 12 per cent. of the energy of the fuel in the form of work, whereas the former engine yields 25 per cent. The Diesel engine even yields 37 per cent. However, according to Sir William White, the introduction of the turbine engine has given the steam engine a new and probably lengthy lease of life.

Liquid fuel possesses the advantages and coal most of the disadvantages. The thermal efficiency, talking in terms of evaporating power for steam, for a pound of oil and a pound of good steam coal, is 17 to 10. On account of increased radius of action for vessels the British Admiralty placed the figures at 18 to 10. Great economy is had in the ready flexibility in the use of oil. In the case of coal, a thick bed of incandescent fuel must be ready and considerable time is necessary to bring this into a condition of active combustion. Clinkers must be removed, labor is involved, and cold air rushes in, which is detrimental to the boiler, besides being wasteful of fuel. In regard to oil, the fueling of a vessel, for example, at sea is a simple matter with a flexible pipe-line. Furthermore, the combustion can be controlled with precision, quickly brought to highest fuel efficiency upon sudden or unusual demand, or cut off entirely. Stoking expenses are cut, and, in the case of locomotives, the stoker can give intelligent assistance to the engine-driver, which is not only of educational value, but a valuable safeguard as well. Attention was directed to the enormous increase in the consumption of oil on the railways in the United States. In 1907 it amounted to 18,885,691 barrels; the length of line operated was 13,593 miles and total length of line covered by oil-burning locomotives 74,197,144 miles or an average of 3,935 miles per barrel of oil consumed. Many large power plants also consume oil fuel in America.

A most spectacular experiment, in the shape of a burning petroleum fountain, was performed as an awe-inspiring illustration of the combustion of liquid fuel, to call attention to the remarkable incident which took place a year ago in one of the Mexican oil fields. A well, 1,824 feet deep, was sunk in a petroliferous formation charged with oil under tremendous pressure. In less than twenty minutes after, the formation was unexpectedly penetrated, the ground around the well began to tremble and fissures, some 250 feet long, appeared. One of these extended under the boiler and, although the fire had been drawn, the gas was ignited. The well burned fifty-eight days, consuming 3,000,000 barrels (estimated) of oil. The flame reached a height of 1,500 feet and at the broadest part was nearly 500 feet in diameter, and was so bright that a newspaper could be read eleven miles away by its light. In addition to the

escaping oil and gas, it was estimated that 1,500,-000 barrels of water were discharged per day, and with the liquid about 2,000,000 tons of solid matter, so that ultimately a crater of 117,600 square meters was formed. The fire was eventually extinguished by pumping sand into the crater with centrifugal pumps.

Words of warning were given in regard to the fear expressed by some as to overproduction of oil; also he wished to dispel any illusions as to the displacement of coal by oil, for the latter constituted but a very small percentage of the fuel used, or that would become available; although no one could say how much petroleum was yet to become available, there was not much likelihood that it could ever revolutionize the fuel industry.

In connection with this address it might be mentioned that series of papers were presented before the metallurgy, organic and law sections upon fuel and methods for determining its value, coal-dust explosions, gas-producers, sources of oils, as shale oil, uses of by-products, and the smoke problem. The International Congress on Petroleum met for two days previous to the congress.

The special lecture which attracted most attention was undoubtedly that of Professor A. Bernthsen on "The Utilization of Atmospheric Nitrogen, Particularly for the Manufacture of Air-saltpeter," given in Professor Armstrong's lecture theater. Having directed attention to the importance of soluble nitrogen compounds for fertilizing purposes, tracing the history of our knowledge of the value of nitrogen in plant and animal life, the lecturer said that of the 2,000,000 tons of Chili saltpeter exported annually Germany took one third. Crookes prophesied that the supply of saltpeter would be exhausted before many years had passed, and by 1935 there would be such a demand for wheat that, even if all the ground now available were planted, the yield per acre must be increased from 12.7 to 20 bushels in order to supply it. Twelve million tons of saltpeter would be required per annum in addition to the 1,750,000 now being used. Even if Chili still had 50,000,000 tons of saltpeter in 1935, the four following years would exhaust it.

The nitrogen of the air amounts to about four billion tons. On the basis of the present annual consumption, allowing no replacement, the air contains enough nitrogen to provide fourteen thousand million years' supply of saltpeter. The world's demand increases by about 100,000 tons per annum. Shortly by the process described, and demonstrated on a large scale by the lecturer, that amount would be placed upon the market every year.

The comparative value of ammonium, nitrate and nitrite compounds was dealt with in some detail and reference made to the sources of these classes of compounds.

The different methods employed in the fixation of atmospheric nitrogen may be divided into three groups. First, direct formation of ammonia from its elements, both of which have to be isolated for the purpose. Second, the formation of metallic nitrides and cyanogen compounds, which are subsequently decomposed into ammonia compounds. And third, those methods which aim at the direct oxidation of atmospheric nitrogen to nitrites or nitrates. These methods were discussed from scientific, practical and economic points of view, attention being given especially to the cyanides, nitrolime, "Stickstoffalk."

In the combustion of nitrogen in oxygen, there is an equilibrium for each temperature between the nitric oxide produced and the nitrogen and oxygen, hence the amount of nitric oxide produced at any temperature can not exceed that corresponding to the state of equilibrium for the particular temperature. The following figures give the percentage produced: at 2,200° C. the gases contain 1 per cent. nitric oxide, at 2,571° C. 2 per cent., at 2,854° C. 3 per cent. and at 3,327° C. 5 per cent. Therefore the air must be heated to as high a temperature as possible and the products cooled as rapidly as possible to reduce the decomposition of the nitric oxide to free nitrogen and oxygen to a minimum.

The numerous methods proposed for accomplishing this, especially that of Cavendish, who in 1785 said it could be accomplished by electric spark discharges, were discussed. Particular attention was given to the modern practical processes of Bradley and Lovejoy, Birkeland and Eyde. The original papers, or this lecture, which may be had in printed form from the Badische Anilin- und Soda-Fabrik, should be consulted for the details. The process of his company, as worked out by Schönherr and Engineer Hessberger in 1905, and claimed to be superior to those of Birkeland and Eyde, was then described. This dispenses with magnets used for creating a strong field, which spreads out the flame into the shape of a flat, more or less circular, disc. Schönherr produces his arc inside an iron tube of compara-

tively small diameter, the air passing through the tube and thus coming into contact with the arc. The arc tube contains an insulated electrode at one end, which can serve itself as the second electrode. "The arc, at its formation, springs from the insulated electrode to an adjacent part of the arc tube which is only a few millimeters away, but the air, which is passing through the tube, being preferably introduced with a tangential or rotary motion, immediately carries the end of the arc along the wall of the tube, so that it either enters the tube at a considerable distance from the electrode, or it ends on a special electrode placed for the purpose, say, at the other end of the arc tube."

There are some modifications, which need not be referred to here. A column of arc flame of very high temperature is obtained burning quietly in the axis of the tube and surrounded by air, which is being passed through the tube. Large quantities of electrical energy may be driven easily and safely through a comparatively small tube. The experimental furnaces at Christianssand are fed with about 600 H.P. at 2,400 volts. The larger furnaces of 1,000 H.P. require 40,000 cubic feet of air per hour and have arcs over twenty feet long.

The nitrogen monoxide produced is readily changed to nitrogen dioxid with oxygen and is absorbed by quicklime in the form of briquettes.

Cheap water power is necessary. A factory is in process of construction at Notodden, Norway, to consume 30,000 H.P. and another, with ten turbines, to develop 140,000 H.P. at Telemarken on the Rjukan.

It is of sentimental, but essentially practical, interest that these processes do not participate in the destruction of valuable coal deposits in obtaining the necessary energy, but use "white coal," which with the constant aid of nature, through the principles of evaporation and condensation, may be used over and over again.

As may be seen from the list of papers presented, the subject of nitrogen availability was one to which great attention was given. In looking over the titles of the papers presented it is suggested that the reader later note the formation of international commissions which are to deal with some most important problems. The members of all the various commissions have not as yet been selected.

On Thursday, May 27, many of the sections met for organization.

Sections I. and VII. held a joint meeting at eleven o'clock, when Martin Ullmann presented reports of the International Commission for the Analysis of Artificial Fertilizers and Feeding Stuffs. The following questions were dealt with:

1. "Ueber die Analyse der Rohphosphate."
2. "International Regelung des Kali-Koeffizienten."
3. "Die Methode König zur Bestimmung der Holz-faser."
4. "Ueber Methoden für die Analyse von Stoffen, dienend zur Bekämpfung der Krankheiten des Weins."

Heinrich Fresenius presented the report "VI. Subkommission der Internationale Analysenkommission."

Section II. The president, Ludwig Mond, delivered his address on "The Metallic Carbonyls."

Section III. Sir Hugh Bell, the president, delivered his address.

Whit-Sunday, May 30, was given over to rest by many, sightseeing by others and numerous parties upon the Thames, which was seen in its best splendor, yet the 300 seats reserved each at St. Paul's Cathedral and Westminster Cathedral for members were occupied, some of whom later attended the garden parties of Dr. and Mrs. Mond and Mr. Robert Mond at their homes, and Dr. and Mrs. Thorne at Kew Gardens.

It is interesting to note that sermons were preached from these historic pulpits along the lines of the "Newer Revelation" harmonizing modern scriptural interpretation with the most advanced scientific conceptions. What a jolly lot of excommunications there might have resulted from these eloquent sermons a century ago!

Excursions were arranged as follows:

Friday, May 28—Laboratories Royal Army Medical College, Millbuth.

Saturday, May 29—Excursion to Rothamsted; London County Council Sewage Works; Hampton Urban District Council Sewage Works; Metropolitan Water Board Water Works; London County Council School of Photo-engraving and Lithography; The Photographic Department of the Polytechnic.

Tuesday, June 1—National Physical Laboratory; Laboratories Metropolitan Water Board.

Wednesday, June 2—Biscuit Factory of Peek, Frean & Co. at Bermondsey; Laboratories of the Inland Revenue Department; visit to Windsor Castle by permission of His Majesty the King. Special trains transported a large number to and fro.

Special resolutions were adopted in several sections. In Section I. (Analytical Chemistry) a general definition for the yield of volatile matter in fuels was proposed and carried. "The percentage which is found by subtracting from one hundred the yield of coke obtained, by the method of the American Committee on Coal Analysis (*Journ. Amer. Chem. Soc.*, 21, p. 1122), from 1 gram of fuel in a bright platinum crucible. The yield must always be calculated upon the pure combustible matter."

In Sections IIIa. and IIIb. (Metallurgy and Explosives) it was *Resolved*, "That it is desirable that the International Commission appointed in Rome in 1906 to consider the standardization of tests for the stability of explosives be reappointed till the next congress."

In Section V. (Sugar) a committee, composed of Messrs. Andrlik, Claassen, Herles, Herzfeld, Pellet, Sachs, Saillard, Strohmer and Villavecchia, was elected to carry out the provisions of a resolution for appointing a "committee for standardizing the concentrations of sugar liquors intended for analysis."

A committee was appointed, consisting of Messrs. Dupont, H. Pellet, Fischmann, Sachs, C. Borgrino and Saillard, to take steps towards furthering the movement for obtaining a reduction of the taxes on sugar advocated by MM. Dupont and Fischmann.

A committee, consisting of Messrs. Pellet, Sachs, Strohmer, Herles, Saillard and Herzfeld, was appointed for drawing up the text of a proposition to be put before the International Commission for Unification of Sugar Analyses for making the aqueous method of Pellet for the analysis of beet the standard one.

The International Commission for the Unification of Methods of Sugar Analysis adopted the following: "That a standard table at a temperature of 20° C. be officially adopted by the commission, and that this table be based on the official German table; and, further, that other tables at different temperatures (such as 15, 17½, 20, etc.) be calculated from the standard one, as also one according to the Mohr system at 20°/20°.

In Section VIIIc. (Bromatology) the International Commission on the Unification of Analytical Methods has issued the following account of their proceedings:

La Commission s'est réunie les vendredi 28, samedi 29 et lundi 31 mai a 9 h.m., sous la présidence de M. André.

Elle a arrêté un réglément d'ordre intérieur; puis elle a examiné et approuvé un projet de rapport sur son organisation et ses travaux.

Elle s'est ensuite occupée des rapports sur l'unification des méthodes d'analyse préparés par MM. André, von Buchka, Chapman, Cribb, Lavalle, Schoepp, Mastbaum, Piutti, Vandevelde, Wauters, Wiley (Voir Séance du samedi 29 de la section de bromatologie).

Enfin elle a procedé au recrutement de quelques membres nouveaux et la constitution de son bureau. M. von Buchka a été élu président; MM. Armand Gautier, Thorpe, Piutti, Schaffer, Wauters, Wiley, Wysman, vice-président; M. Vandevelde, sécretaire général.

After a lengthy discussion, in which many took part, this resolution was carried: "That brandy is a product of the distillation of wine, and the term is synonymous with eau de vie de vin."

In Section IX. (Photo-chemistry) R. Namias and L. P. Clerc, by request of the permanent committee of the International Congresses of Photography, laid before the section the provisional program of the fifth International Congress of Photography to be held at Brussels in July, 1910, during the International Exhibition.

R. Namias, in the name of the Societa Fotografica Italiana, of Florence, presented to the section an album containing a large number of photogravures of Messina and Reggio representing the effects of the recent lamentable disaster. These prints constitute the greatest known work of photographic record. The text is printed in four languages, and the publication is on behalf of the institution established to assist destitute orphans.

In Section X (Electro- and Physical Chemistry) it was proposed and carried that a committee composed of the following members—Messrs. Abegg, Bancroft, Bodenstein, Bruni, Carrara, Dutoit, Findlay, Kistiakowski, Lewis, Lunden, Marie, Mourels, Rothmund, Urbain, Walden and Wilsmore—be appointed to deal with the values of physical-chemical constants.

A committee (not yet announced) to deal with the general question of thermochemical notation was also authorized.

The official closing general meeting occurred in the Great Hall of the Imperial Institute, Sir William Ramsay presiding, supported by Sir Henry Roscoe, and presidents of previous congresses present, Professors Witt, Lindet, Gautier and Paternò.

It was announced that 3,000 members had joined the congress with 650 ladies.

Reports of the several sections were presented with the resolutions recommended for adoption. All were approved except those bearing upon certain patent legislation. These were postponed to the next congress.

The following resolutions from the sections were put to the meeting:

Section I.—

1. "En vue d'unifier les méthodes d'analyse et de récherche dans l'essai des essences de produits résineux, le congrès international de chimie appliquée émet le vœu de voir s'établir par les soins de la Section I. un tableau définissant les bases à utiliser dans l'estimation la pureté des sousdits produits et dont l'usage serait fortement recommandé a tous les analystes."

2. "The institution of official methods for agricultural analyses is undesirable, unless subject to periodical revision."

3. "The Seventh International Congress of Applied Chemistry considers that it is desirable to adopt uniform principles in connection with the application of reference tests, and is of opinion that the proposals made by Professor T. W. Fresenius constitute a suitable basis for these principles."

Section IVa. bis. "That the section in future congresses be a separate and independent section entitled Biochemistry, including pharmacology."

Section VIb. "That this meeting, being in sympathy with the suggestion of Professor Lindner to form a central bureau for fermentation organisms, hereby empowers him to write to the council of the Institute of Brewing (London) as to how such a project could be carried into effect."

Section VIIIa.

1. "That the congress requests the various governments to nominate a commission to make researches in collaboration with manufacturers on materials used in the ceramic arts, to encourage the use of substances not containing lead; to restrain the use of lead materials, and to conduct further researches with regard to protective materials for the hygienic use of those engaged in the ceramic industries."

Reports were received from the International Commission for the Unification of Analytical Methods, which body held short sessions on the mornings of May 29 and 31 and June 1, between 9 and 10 A.M. At these certain resolutions were passed, which were communicated verbatim to the general meeting on June 2.

On the occasion of the discussion on brandy a resolution was passed embodying a definition of the word "brandy."

2. In conjunction with Sections IIIa. and XI. "The congress is requested to appoint a committee to impress upon the governments of each country represented at the congress the importance of adopting a uniform law throughout their respective territories regarding the emission of noxious fumes from chemical and metallurgical works and of black smoke from works and factories. The section believes that the abatement of atmospheric pollution will be most rapidly secured by placing the control of all such gaseous emanations in the hands of fully qualified inspectors capable of giving the necessary technical advice to manufacturers. It records its conviction that the dispersal of the pall of smoke covering certain industrial districts in England and elsewhere will be accompanied by enormous benefit to the inhabitants, and will prove an ultimate gain to the manufacturer."

Section VIIIb. "That this meeting of the Pharmaceutical Chemistry Section of the International Congress of Applied Chemistry having received and discussed communications by Messrs. Squire and Caines and MacEwan and Forrester, resolves that it is desirable that an international enquiry should be instituted with a view to securing: (1) greater uniformity in the commercial supplies of potent drugs and the means for determining the same, and (2) approximation in the pharmacopœias of the world to common standards of activity. With a view to advancing these objects this meeting further recommends that the following provisional committee be appointed to enquire and report on the subject to the next meeting of the congress: Messrs. P. W. Squire and F. Ransom (Great Britain), Professors H. Thoms and E. Schmidt (Germany), Professor E. Bourquelot and M. Leger (France), Professors Piutti and Guareschi (Italy), Professors Remington and Rusby (United States), with P. MacEwan (Great Britain and United States) and G. P. Forrester (European Continent) as secretaries. This meeting recommends that the provisional committee shall have power to invite as members with equal rights persons who have interested themselves in this subject, and further that this resolution shall be conveyed to the governments and pharmacopœial authorities who were represented at the Brussels Conference (1902) on the unification of potent remedies."

Section XI.—

1. "That the committees of the various countries party to the International Convention for the Protection of Industrial Property be requested to consider the desirability of adopting the following provision: 'The manufacture in one country of the union protects the patentee against the revocation of his patent in all countries of the union.'"

2. "The section recommends the question raised by M. de Laire's paper on 'The International Patent' to the attention of the International Association for the Protection of Industrial Property and to the national committees for study with a view to future congresses."

3. "That international committees be appointed representative of all the nations party to the Congress to consider and draft proposals for joint international patent and trade mark legislation, with a view to international uniformity, such proposals to be laid before the congress of 1912 for discussion and further action."

4. "That the congress deprecates any patent legislation limiting the patentability of pharmaceutical products."

5. "To commit the question of international acknowledgment of the right of prior use within the states adhering to the International Convention to the International Association for the Protection of Industrial Property for further consideration."

6. "That the congress expresses the wish that there should be created an 'international depôt de plis cachetes.'"

7. "That it is necessary that a fancy name designating a medicinal compound of definite composition should be protected as a trade mark as securely as such a name applied to a secret remedy or a remedy of indefinite composition."

8. "It is desirable that all manufacturing countries, notably Germany, Great Britain and the United States, adhere to the Madrid Convention concerning international trade-mark registration, and that this arrangement should be raised at the next conference in the sense that: (*a*) registration of a trade mark at the Berne Bureau should only have a formal effect; (*b*) that the deposit at the Berne Bureau be independent of registration in the country of origin."

9. "That an international commission be appointed for the study of technical rules defining requisites, to which should correspond the principal chemical products commercially known as commercial products."

10. "That the work of this commission should be considered as part of the work of the Congress of Applied Chemistry."

11. "That a subsection dealing with the chemistry of petroleum should, in the future, be a subsection of the congress."

12. "That an international commission be appointed to establish uniformity in the control of the escape of noxious gases."

13. "That each succeeding Congress of Applied Chemistry do examine and report upon the progress and position of chemical industry in each of the countries party to the congress, having particular regard to the country in which the congress is for the time being held, and to the relation between the development of chemical industry and customs' tariffs."

Monsieur Lindet proposed that the International Commission on Analyses be continued with a grant of 2,000 frs. It was approved.

The Hon. Whitelaw Reid, the American Ambassador, at the request of the American delegates, presented the official invitation of the government to hold the eighth congress in 1912 in this country. After reading and submitting the instructions of the Secretary of State, the Hon. P. C. Knox, to the American commissioners, Mr. Reid made a most felicitous speech, insisting upon the acceptance of the invitation. There were reasons why the delegates to that congress should feel at home in the United States. One large section of that great country was called New England. There were many large sections of it which might properly be called New Ireland. (Laughter.) Certainly the people in those sections had shown great capacity for self-government and for governing the Americans. (Laughter.) There were also many sections which might properly be called New Germany, and a whole region in the northwest that might be called New Sweden and Norway. The historic claims of the Dutch in America were commemorated in New Amsterdam, and the Italians, who discovered the country, would find many of their countrymen still there to welcome them. (Cheers.) The delegates, if they accepted his invitation, would go next to a country which looked especially on the work of science as, above all, tending to promote happiness and diffuse peace among the nations of the earth. (Cheers.)

Dr. Wiley, of the Department of Agriculture, Washington, seconded the invitation, and said that

according to the last census over 10,000,000 of the citizens of the United States had been born in foreign lands. Thus, an eighth of the whole population of the United States were foreigners who had been received into citizenship. The delegates of every nationality could count upon being welcomed in their own tongue.

Professor Meldola, representing the Society of Chemical Industry, in supporting the invitation, said it was the first time in the history of the congress that the delegates had received a direct message from the ruler of a great nation asking them to meet in his country. (Cheers.)

The invitation was accepted with acclamation.

The president then proposed Professor E. W. Morley as honorary president and Dr. W. H. Nichols as acting president for the next congress.

Dr. Otto N. Witt seconded the nominations, saying that the success of the past congresses had been due largely to the circumspect choice of presidents, and the nominees presented guaranteed the success of the next.

Dr. Chas. Baskerville, in supporting the nominations, spoke of the appreciation of the teachers of chemistry of the choice, because Professor Morley had been the successful investigating teacher and all teachers of chemistry knew they had no better friend than that captain chemical technologist, Dr. Nichols.

The nominees were elected with acclaim.

Dr. Nichols made a modest speech of acceptance and assured the congress of a cordial reception on the part of all Americans.

Dr. Wiley proposed that the official delegates from the United States be nominated members of the organizing committee, with power to add to their number. This proposal was seconded by Professor Clarke and carried.

6. The president proposed that a permanent officer (Delégué des Presidents) be appointed by the International Commission of the Congresses of Applied Chemistry. This was passed after Dr. Nichols had suggested that the expense be borne by the succeeding congress in each case. It is intended that this official after publishing the proceedings of one congress take up his residence in that country where the next congress is to be held and there give the organizing committee that aid it may require.

Sir Henry Roscoe proposed, and Professor Carl Duisberg seconded, the following motion: "That all communications to the congress be submitted to an English publication committee, on the understanding that they be judged with perfect fairness and impartiality." It was carried.

The following delegates then addressed the meeting, expressing thanks:

Monsieur Lindet, as president of a former congress; Dr. Francisco P. Lavalle, Argentina; K.K. Regieurungsrat F. Strohmer, Austria; M. Francois Sachs, Belgium; Mr. Ou Kouanze, China; Senor Don Francisco Becerra, Colombia; Dr. Luis E. Mourgues, Chile; Mr. G. A. Hagemann, Denmark; Senor Don C. Nevares, Ecuador; Professor Armand Gautier, France; Geheimer Regierungsrat Professor von Buchka, Germany; Dr. P. D. Zacharias, Greece; M. Nikolaus Gerster, Hungary; Senatore Emanuele Paternò, Italy; Professor Mitsuru Kuhara, Japan; Dr. Hoogewerff, The Netherlands; Mr. Samuel Eyde, Norway; Dr. Hugo Mastbaum, Portugal; Dr. L. Edeleanu, Roumania; Professor N. Tavildaroff, Russia; Professor Marco T. Lecco, Servia; Professor E. Pinerua y Alvarez, Spain; Professor P. Klason, Sweden; Professor Dr. E. Bosshard, Switzerland; Dr. David P. Day, United States.

The president declared the congress closed, after a most successful meeting.

The American commissioners were Dr. H. W. Wiley, chairman, representing the government, with Drs. F. W. Clarke, David T. Day and Allerton S. Cushman; Dr. W. H. Nichols, representing chemical manufacturers and the American Chemical Society; Dr. Francis Wyatt, technical analytical chemist; Dr. Leo H. Baekeland, the American Electro-chemical Society; Mr. Maximilian Toch, chairman New York Section of the Society of Chemical Industry; Dr. Morris Loeb, president of the Chemists' Club; Mr. Albert Plant, the manufacturing druggists; and Professor W. L. Dudley, Vanderbilt University, and Professor Chas. Baskerville, College City of New York, representing the teachers of chemistry.

In addition to the American commissioners, all of whom were present, the following attended from the United States: Mr. E. A. Sperry, Mr. E. R. Taylor, Mr. Carleton Ellis, Dr. E. A. Byrnes, Dr. Walker Bowman, Dr. Jokichi Takaminé, Dr. Hugo Schweitzer, Mr. Hugo Lieber, Mr. Henry Wigglesworth, Dr. Bernard C. Hesse, Dr. W. D. Horne, Dr. Arthur M. Comey, Dr. Chas. L. Reese, Dr. E. Gudeman, Dr. H. M. Smith, Dr. R. Kennedy Duncan, Dr. Arthur Elliott, Mr. Wm. J. Evans, Mr. Wm. S. Gray, Mr. I. F. Stone, Mr. David Wesson, Mr. T. J. Wrampelmeier, Dr. W. D. Harkins, Dr. H. B. Hite, and others whose names your reporter did not secure.

CHAS. BASKERVILLE

SCIENCE

Friday, September 24, 1909

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SAMUEL WILLIAM JOHNSON

In the death of Samuel William Johnson the chemists of America have lost one more from that small band who, two generations ago, undertook to extend and develop the beginnings which had been made to establish laboratories for instruction in chemistry and to apply this science to the industries of the country. Among these men, most of whom have already passed away, few left a greater impress on American chemistry or American chemists than did Professor Johnson, for his whole life was devoted to training workers in his chosen field, to making others realize what chemistry could do for them and to developing institutions and methods to extend the knowledge of chemistry and make this available to those engaged in productive occupations. The principal field to which he devoted his efforts was the application of science to agriculture, the results of which efforts are far better appreciated to-day, when the practical returns are so apparent than they were during the years of his greatest activity when he was patiently struggling against the conservatism of the so-called practical men who were persuaded with difficulty to make the beginning which was essential to demonstrate the truth of what he was trying to teach them.

Professor Johnson was born July 3, 1830, in Kingsboro, Fulton County, New York. His parents were of Connecticut origin but were taken by their parents to New York state when children. Although his father spent most of his active life in successful business he early retired to a large and fertile farm, soon after 1830,

and on this farm Professor Johnson spent his boyhood. He thus early became familiar with practical agriculture.

His father's training and experience in business led him to take a keen interest in the problems presented to the farmer and his discussion of such questions awakened an interest in his son to know more of the principles upon which the processes depended which he daily saw in progress about him.

At the age of ten he entered the Lowville Academy where he remained seven years and there came under the influence and instruction of David Porter Mayhew, who was an enthusiastic student of the natural sciences. Mayhew had then recently secured the means of establishing a chemical laboratory and in this laboratory Professor Johnson obtained his first knowledge of chemistry and, as he once wrote, "there became fascinated with chemistry through the brilliantly illustrated lectures of the principal." Mayhew made him his assistant, and, in 1846, presented him with a then recently published translation of Fresenius's Chemical Analysis. The possession of this book led him to equip a laboratory at his own home in which he prepared most of the reagents described, and worked through the qualitative course.

In his first note-book, dated June, 1848, he described his laboratory as nearly completed and begins with an account of his first attempt to prepare distilled water. This book contains many interesting accounts of the difficulties he encountered in preparing his reagents, and gives an insight into the training he thus got at the beginning of his chemical career which left its marked impress on his habits of work and thought throughout the remainder of his life.

The ability to rely on his own resources and to overcome difficulties by persistent effort soon developed a degree of self-confidence which enabled him to continue his studies in the face of difficulties which to most boys of his age would have seemed insurmountable. Although his father was interested in his chemical work he considered it an uncertain means for gaining a livelihood and opposed his son's determination to adopt it as his life work. He therefore undertook to show that he could support himself and so engaged in teaching in various schools at intervals for three years.

Having saved some money he entered the laboratory at Yale in 1850 and continued his studies with Benjamin Silliman and John P. Norton. His funds giving out, he again took up teaching and was so successful that his father became convinced that he had the capacity to take care of himself and decided to give him an opportunity to gain the education he had determined to secure.

After returning to Yale for another year he went abroad in 1853 and entered Erdmann's laboratory in June, where he stayed until the next April, studying various problems in organic and inorganic chemistry as well as attending lectures in other subjects. The next year he spent in Munich in the laboratory of Liebig and also studied with von Kobel and Pettenkofer. As a student at Munich he won the respect and friendship of Liebig, who followed with interest his later career and for several years after continued a correspondence with him. In 1855 he went to Paris, where he attended Chevereul's lectures. He spent the summer in England and worked for a short time with Frankland.

In September he returned to New Haven and took charge of the laboratory of the Yale Scientific School as chief assistant in

chemistry. The next year he was appointed to the new professorship of analytical chemistry. In 1857 he succeeded John A. Porter in the chair of agricultural chemistry and continued to give instruction in both these subjects until 1875, when he became professor of theoretical and agricultural chemistry. From 1870 until his retirement in 1895 he also gave instruction in organic chemistry.

Professor Johnson's agricultural work began while he was yet a student in his own laboratory in New York state. In 1847, when he was only seventeen years old, his first paper, "On fixing Ammonia," was published in the *Cultivator*. This was followed during the next few years by many other papers in this and other agricultural journals on various topics concerning the application of science to agriculture. After coming to Yale he continued his writings on agricultural science, and in 1856 read a paper to the Connecticut State Agricultural Society which led to his appointment as chemist to this society. In 1866 he became a member of the first Connecticut State Board of Agriculture and two years later its official chemist.

In 1873 he devoted his energies to the establishment of an agricultural experiment station in this state and spent much time visiting all parts of the state and arousing an interest in this subject. The work that he had done as chemist to the Agricultural Society and the State Board of Agriculture did much to make the advantages of such an institution evident to those engaged in farming. In 1877 an act was passed by the legislature establishing such an institution and he was appointed its director. The work that he had done for more than twenty years among the farmers of Connecticut had at last born fruit and the duty of organizing and developing the new institution occupied him, in addition to his college duties, during the twenty years succeeding.

Although the act incorporating the new station stated that its aim was "to promote agriculture by scientific investigation and experiment" his experience in bringing about its establishment showed him that it was necessary to devote a large part of his energies to work that would readily be recognized as of immediate pecuniary value to the farmer. Though his chief interest then, as always, lay in purely scientific research work on fundamental problems of agricultural science which he believed would be of greater value to agricultural practise, he felt it most important during the early years of the development of the institution to devote the larger part of its resources to such work as would win popular support for the institution. Most of his time, therefore, was given to establishing an effective fertilizer control and to improving the methods of practise on dairy farms and to perfecting the methods of agricultural analysis.

The limited resources of the station left little to be applied to the study of purely scientific problems, but such work as could be done along these lines was followed as far as possible, and to an increasing extent, as the resources of the station became larger. In his later years it was a constant source of regret that he was not able to take personal part in the research work which the federal funds now make possible in the institution he had founded. Many times he recalled to the writer the limited resources with which he had to work and expressed his regret that he had not been able to do the research work that he had for so long hoped to have the facilities to carry out.

By developing the details of station work and methods, by establishing high

standards of fair dealing both with the farmer and with those who supplied him, and by inspiring all who were associated with him with high ideals of scientific work he did more than any other man to make the experiment stations of the country the useful and successful institutions that they are. Those familiar with the details of his work can see the impress of what he did in countless ways in the methods now in use not only in the offices and laboratories of the other stations, but in many other laboratories devoted to other lines of work. His influence among those who have succeeded him in applying science to agriculture has been great, and he has had the pleasure of living to see others carrying out the plans which, in his youth, he hoped to carry out himself.

Professor Johnson achieved distinction not only as a teacher and as a promoter of agricultural science, but he won a high reputation among the legal profession by the great ability he showed as an expert in many important cases in court. The profound knowledge which he brought to bear on these cases, the great care and accuracy with which he performed the analytical work involved, the thoroughness with which he prepared every detail, and the clear and logical way in which he set forth his conclusions, have many times been recounted to the writer by leaders of the bar, and have always been accompanied with expressions of the highest admiration and respect for the ability he displayed.

Naturally of a retiring disposition and disinclined to acquire publicity by gaining positions of prominence in societies and public associations, he still took part with others in such organizations as he thought would contribute to the advancement of the sciences to which he was at heart devoted. Thus we find him at the age of twenty-one reading a paper before the American Association for the Advancement of Science of which he became a member at about this time. Later, in 1875, he was chairman of its sub-section of chemistry. In 1866 he was elected a member of the National Academy of Sciences and served on its committee on Sorghum sugar in 1881. He was long a member of the American Chemical Society and its president in 1878. He was one of the original members of the American Association of Official Agricultural Chemists and its president in 1888 and also president of the American Association of Agricultural Colleges and Experiment Stations in 1896.

Professor Johnson had a strong love of literature and was noted for his literary style and the simplicity and clearness with which he wrote. That this was a natural gift is evident from his paper "On the Houghite of Prof. Shepard," written when he was only twenty-one, in which he sets forth the results of his investigation with the skill of one who had had careful training and long experience in such work. His assured and finished style is shown in all his early contributions to the agricultural papers for which he wrote. That his most widely read book "How Crops Grow" was translated into nearly every civilized language was largely due to the purity and conciseness of the style in which it was written, for the character of this book was such that it would have been easy to rewrite the material into a new form and put it out as a new book.

While constantly occupied with scientific work Professor Johnson found time to keep himself informed of all that was new in nearly every branch of chemistry and agricultural science, and he also read much of general literature and of poetry, of which he had a high literary appreciation.

As a man Professor Johnson had a most

attractive personality which endeared him to all who were intimately associated with him. His kindly interest in his students and assistants and his many generous and helpful deeds in their behalf will long be remembered by those who had the good fortune to work with him.

THOMAS B. OSBORNE

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE[1]

ADDRESS OF THE PRESIDENT TO THE PHYSIOLOGICAL SECTION

THE PHYSIOLOGICAL BASIS OF SUCCESS

DURING past years it has been customary for the presidents of sections in their addresses either to give a summary of recent investigations, in order to show the position and outlook of the branch of science appertaining to the section, or to utilize the opportunity for a connected account of researches in which they themselves have been engaged, and can therefore speak with the authority of personal experience as well as with that imparted by the presidential chair. The growing wealth of publications with the special function of giving summaries and surveys of the different branches of science, drawn up by men ranking as authorities in the subject of which they treat, renders such an interpretation of the presidential duties increasingly unnecessary, and the various journals which are open to every investigator make it difficult for me to give in an address anything which has not already seen the light in other forms. The association itself, however, has undergone a corresponding modification. Founded as a medium of communication between workers in different parts of the country, it has gradually acquired the not less important significance of a tribunal from which men of science, leaving for a time their laboratories, can speak to an audience of intelligent laymen, including under this term all those who are engaged in the work of the world other than the advancement of science. These men would fain know the lessons that science has to teach in the living of the common life. By standing for a moment on the little pinnacle erected by the physicist, the chemist or the botanist, they can, or should be able to, gain new hints as to the conduct of the affairs of themselves, their town or their state. The enormous advance in the comfort and prosperity of our race during the last century has been due to the application of science, and this meeting of the association may be regarded as an annual mission in which an attempt is made to bring the latest results of scientific investigation into the daily routine of the life of the community.

We physiologists, as men who are laying the foundation on which medical knowledge must be built, have as our special preoccupation the study of man. Although every animal, and indeed every plant, comes within the sphere of our investigations, our main object is to obtain from such comparative study facts and principles which will enable us to elucidate the mechanism of man. In this task we view man, not as the psychologist or the historian does, by projecting into our object of study our own feelings and emotions, but by regarding him as a machine played upon by environmental events and reacting thereto in a way determined by its chemical and physical structure.

Can we not learn something of value in our common life by adopting this objective point of view and regarding man as the latest result of a continuous process of evolution which, begun in far-off ages, has formed, proved and rejected myriads of types before man himself appeared on the surface of the globe?

[1] Winnipeg, 1909.

Adaptation.—In his study of living beings, the physiologist has one guiding principle which plays but little part in the sciences of the chemist and physicist, namely, the principle of adaptation. Adaptation or purposiveness is the leading characteristic of every one of the functions to which we devote in our text-books the chapters dealing with assimilation, respiration, movement, growth, reproduction, and even death itself. Spencer has defined life as "the continuous adjustment of internal relations to external relations." Every phase of activity in a living being is a sequence of some antecedent change in its environment, and is so adapted to this change as to tend to its neutralization and so to the survival of the organism. This is what is meant by adaptation. It will be seen that not only does it involve the teleological conception that every normal activity must be for the good of the organism, but also that it must apply to *all* the relations of living beings. It must therefore be the guiding principle, not only in physiology, with its special preoccupation with the internal relations of the *parts* of the organism, but also in the other branches of biology, which treat of the relations of the living animal to its environment and of the factors which determine its survival in the struggle for existence. Adaptation therefore must be the deciding factor in the origin of species and in the succession of the different forms of life upon this earth.

Origin of Life.—A living organism may be regarded as a highly unstable chemical system which tends to increase itself continuously under the average conditions to which it is subject, but undergoes disintegration as a result of any variation from this average. The essential condition for the survival of the organism is that any such disintegration shall result in so modifying the relation of the system to the environment that it is once more restored to the average in which assimilation can be resumed.

We may imagine that the first step in the evolution of life was taken when, during the chaotic chemical interchanges which accompanied the cooling down of the molten surface of the earth, some compound was formed, probably with absorption of heat, endowed with the property of polymerization and of growth at the expense of surrounding material. Such a substance could continue to grow only at the expense of energy derived from the surrounding medium, and would undergo destruction with any stormy change in its environment. Out of the many such compounds which might have come into being, only such would survive in which the process of exothermic disintegration tended towards a condition of greater stability, so that the process might come to an end spontaneously and the organism or compound be enabled to await the more favorable conditions necessary for the continuance of its growth. With the continued cooling of the earth, the new production of endothermic compounds would probably become rarer and rarer. The beginning of life, as we know it, was possibly the formation of some complex, analogous to the present chlorophyll corpuscles, with the power of absorbing the newly penetrating sun's rays and of utilizing these rays for the endothermic formation of further unstable compounds. Once given an unstable system such as we have imagined, with two phases, viz., (1) a condition of assimilation or growth by the endothermic formation of new material; (2) a condition of "exhaustion," in which the exothermic destructive changes excited by unfavorable external conditions came to an end spontaneously—the great principle of

natural selection or survival of the fittest would suffice to account for the evolution of the ever-increasing complexity of living beings which has occurred in the later history of this globe. The adaptations, *i. e.*, the reactions of the primitive organism to changes in its environment, must become continually more complex, for only by means of increasing variety of reaction can the stability of the system be secured within greater and greater range of external conditions. The difference between higher and lower forms is therefore merely one of complexity of reaction.

The naked protoplasm of the plasmodium of *Myxomycetes*, if placed upon a piece of wet blotting-paper, will crawl towards an infusion of dead leaves, or away from a solution of quinine. It is the same process of adaptation, the deciding factor in the struggle for existence, which impels the greatest thinkers of our times to spend long years of toil in the invention of the means for the offense and defense of their community or for the protection of mankind against disease and death. The same law which determines the downward growth of the root in plants is responsible for the existence to-day of all the sciences of which mankind is proud.

The difference between higher and lower forms is thus not so much qualitative as quantitative. In every case, whatever part of the living world we take as an example, we find the same apparent perfection of adaptation. Whereas, however, in the lower forms the adaptation is within strictly defined limits, with rise in type the range of adaptation steadily increases. Especially is this marked if we take those groups which stand, so to speak, at the head of their class. It is therefore important to try and find out by a study of various forms the physiological mechanism or mechanisms which determine the increased range of adaptation. By thus studying the physiological factors, which may have made for success in the struggle for dominance among the various representatives of the living world, we may obtain an insight into the factors which will make for success in the further evolution that our race is destined to undergo.

It is possible that, even at this time, objections may be raised to the application to man of conclusions derived from a study of animals lower in the scale. It has indeed been urged, on various grounds, that man is to be regarded as exempt from the natural laws which apply to all the other living beings. When we inquire into the grounds for assuming this anomic, this outlawed condition of man, we generally meet with the argument that man creates his own environment and can not therefore be considered to be in any way a product of it. This modification or creation of environment is, however, but one of the means of adaptation employed by man in common with the whole living kingdom. From the first appearance of life on the globe we find that one of the methods adopted by organisms for their self-preservation is the production of some artificial surroundings which protect them from the buffeting of environmental change. What is the mucilaginous envelope produced by microorganisms in presence of an irritant, or the cuticle or shell secreted by the outermost cells of an animal, but the creation of such an environment? All unicellular organisms, as well as the units composing the lowest metazoa, are exposed to and have to resist every change in concentration and composition of the surrounding water. When, however, a body cavity or *cœlom*, filled probably at first with seawater, made its appearance, all the inner cells of the organism were withdrawn from the disturbing influence of variations in

the surrounding medium. The cœlomic fluid is renewed and maintained uniform in composition by the action of the organism itself, so that we may speak of it as an environment created by the organism. The formation of a body cavity filled with salt solution at once increased the range of adaptation of the animals endowed therewith. Thus it enabled them to leave the sea, because they carried with them the watery environment which was essential for the normal activity of their constituent cell units. The assumption of a terrestrial existence on most parts of the earth's surface involved, however, the exposure to greater ranges of temperature than was the case in the sea, and indicated the necessity for still further increase in the range of adaptation. Every vital process has its optimum temperature at which it is carried out rapidly and effectively. At or a little above freezing point the chemical processes concerned in life are suspended, so that over a wide range of the animal kingdom there must be an almost complete suspension of vital processes during the winter months, and at all times of the year a great dependence of the activity of these processes on the surrounding temperature. It is evident that a great advantage in the struggle for existence was gained by the first animals which succeeded in securing thermal as well as chemical constancy of environment for their cells, thus rendering them independent of changes in the external medium. It is interesting to note that the maintenance of the temperature of warm-blooded animals at a constant height is a function of the higher parts of the central nervous system. An animal with spinal cord alone reacts to changes of external temperature exactly like a cold-blooded animal, the activity of its chemical changes rising and falling with the temperature. In the intact mammal, by accurately balancing heat loss from the surface against heat production in the muscles, the central nervous system ensures that the body fluid which is supplied to all the active cells has a temperature which is independent of that of the surrounding medium. These are fundamental examples of adaptation effected by creation of an environment peculiar to the animal. Numberless others could be cited which differ only in degree from the activity of man himself. In some parts of this country, for instance, the activity of the beaver in creating an artificial environment has until lately been more marked than that of man himself. We are not justified, then, in regarding mankind as immune to the operation of natural forces which have determined the sequence of life on the surface of the globe. The same laws which have determined his evolution and his present position as the dominant type on the earth's surface will determine also his future destiny.

We are not, however, dealing with or interested in simple survival. Lower forms of life are probably as abundant on the surface of the globe as they were at any time in its history. Survival, as Darwin pointed out, is a question of differentiation. When in savage warfare a whole tribe is taken captive by the victorious enemy, the leaders and fighting men will be destroyed, while the slaves will continue to exist as the property of the victors. Survival, then, may be determined either by rise or by degradation of type. Success involves the idea of dominance, which can be secured only by that type which is the better endowed with the mechanisms of adaptation required in the struggle against other organisms.

Among the many forms of living matter which may have come into being in the earlier stages of the history of the earth,

one form apparently became predominant and must be regarded as the ancestor of all forms of life, whether animal or vegetable, viz., the nucleated cell. The almost complete identity of the phenomena involved in cell division throughout the living kingdom indicates that all unicellular organisms and all organisms composed of cells have descended from a common ancestor, and that the mode of its reproduction has been impressed upon all its descendants throughout the millions of years which have elapsed since the type was first evolved. The universal distribution of living cells renders it practically impossible for us to test the possibility of a spontaneous abiogenesis or new formation of living from non-living matter at the present time. We can not imagine that all the various phenomena which we associate with life were attributes of the primitive life stuff. Even if we had such stuff at our disposal, it would be difficult to decide whether we should ascribe the possession of life to it, and there is no doubt that any such half-way material would, directly it was formed, be utilized as pabulum by the higher types of organism already abounding on the surface of the globe.

Integration and Differentiation.—An important step in the evolution of higher forms was taken when, by the aggregation of unicellular organisms, the lowest metazoon was formed. In its most primitive forms the metazoon consists simply of a cell colony, but one in which all individuals are not of equal significance. Those to the outer side of the mass, being exposed to different environmental advantages from those within, must even during the lifetime of the individual have acquired different characteristics. Moreover, the sole aim of such aggregation being to admit of cooperation by differentiation of function between the various cell units, the latter become modified according to their position, some cells becoming chiefly alimentary, others motor, and others reproductive. Cooperation and differentiation are, however, of no use without coordination. Each part of the organism must be in a position to be affected by changes going on in distant parts, otherwise cooperation could not be effected. This cooperation in the lowest metazoon seems to be carried out by utilization of the sensibility to chemical stimuli already possessed by the unicellular organism. We have thus coordination by means of chemical substances ("hormones") produced in certain cells and carried thence by the tissue fluids to other cells of the body, a mechanism of communication which we find even in the highest animals, including man himself. To such chemical stimuli we may probably ascribe the accumulation of wandering mesoderm cells—*i. e.*, phagocytes—in an organism such as a sponge, around a seat of injury or any foreign substance that has been introduced. By this mechanism it is possible for distant parts of the body to react to stimulation of any one part of the surface. Communication by this means is, however, slow, and may be compared to the state of affairs in civilized countries before the invention of the telegraph, when messengers had to ride to different parts of the kingdom in order to arouse the whole nation for defense or attack.

Foresight and Control.—Increased speed of reaction and therefore increased powers in the struggle for existence were obtained when a nervous system was formed, by a modification of the cells forming the outer surface of the organism. By the growth of long processes from these cells a conducting network was provided, running through all parts of the body and affording a channel for the rapid propagation of

excitation from the surface to the deeper parts, as well as from one part of the surface to another. From this same layer were produced the cells which, as muscle fibers, would act as the motive mechanism of the organism. Thus, from the beginning, the chief means of attack or escape were laid down in close connection with the surface from which the stimuli were received. A further step in the evolution of the nervous system consisted in the withdrawal of certain of the sensory or receptor cells from the surface, so that a specially irritable organ, the central nervous system, was evolved, which could serve as a distributing center for the messages or calls to action initiated by changes occurring at the surface of the body. At its first appearance this central nervous system would hardly deserve the epithet of "central," since it formed a layer lying some distance below the surface, and extending over a considerable area; though we find that very soon there is an aggregation of the special cells to form ganglia, each of which might be regarded as presiding over the reactions of that part of the animal in which it is situated. Thus in the segmental worm-like animals a pair of ganglia is present in each body segment, and the chain of ganglia are united by longitudinal strands of nerve fibers to form the ganglionated cord, or central nervous system.

Such a diffused nervous system, in which all ganglia were of equal value, could, however, only act for the common weal of the whole body when a reaction initiated by stimulation at one part was not counteracted by an opposing reaction excited from another part of the surface. For survival it is necessary that in the presence of danger, *i. e.*, an environment threatening the life of the individual or race, the whole activities of the organism should be concentrated on the one common purpose, whether of escape or defense. This could be effected only by making one part of the central nervous system predominant over all other parts, and the part which was chosen for this predominance was the part situated in the neighborhood of the mouth. This, in animals which move about, is the part which always precedes the rest of the body, and therefore the part which first experiences the sense impressions, favorable or dangerous, arising from the environment. It is this end that has to appreciate the presence or approach of food material, as well as the nature of the medium into which the animal is being driven by the movements of its body. Thus a predominance of the front end of the nervous system was determined by the special development at this end of those sense organs or sensory cells which are *projicient* —*i. e.*, are stimulated by changes in the environment proceeding from disturbances at a distance from the animal. The sensory organs of vision and the organs which correspond to our olfactory sense organs and are aroused by minute changes in chemical composition of the surrounding medium, are always found especially at the front or mouth end of the organism. The chances of an animal in the struggle for existence are determined by the degree to which the responses of the animal to the *immediate* environment are held in check in consequence of stimuli arising from *approaching* events. The animal, without power to see or smell or hear its enemy, will receive no impulse to fly until it is already within its enemy's jaws. It must therefore be an advantage to any animal that the whole of its nervous system should be subservient to those ganglia or central collections of nerve cells which are in direct connection with the projicient sense organs in the head. This subservi-

ence is secured by endowing the head center with a power, firstly, of controlling and abolishing the activities (*i. e.*, all those aroused by external stimuli) of all other parts of the central nervous system, and, secondly, of arousing these parts to a reaction immediately determined by the impression received from the projicient sense organs of the head and originated by some change in the surroundings of the animal which has not yet affected the actual surface of its body.

Education by Experience.—The factors which so far determine success in the struggle for predominance are, in the first place, foresight and power to react to coming events, and, in the second place, control of the whole activities of the organism by that part of the central nervous system which presides over the reaction. The animal therefore profits most which can subordinate the impulses of the present to the exigencies of the future.

An organism thus endowed is still, however, in the range of its reactions, a long way behind the type which has attained dominance to-day. The machinery we have described, when present in its simplest form, suffices for the carrying out of reactions or adaptations which are determined immediately by sense impressions, advantage being given to those reactions which are initiated by afferent stimuli affecting the projicient sense organs at the head end of the animal. With the formation of the vertebrate type, and probably even before, a new faculty makes its appearance. Up to this point the reactions of an animal have been what is termed "fatal," not in the sense of bringing death to the animal, but as inexorably fixed by the structure of the nervous system inherited by the animal from its precursors. Thus it is of advantage to a moth that it should be attracted by, and fly towards light objects—*e. g.*, white flowers—and such a reactivity is a function of the structure of its nervous system. When the light object happens to be a candle flame the same response takes place. The first time that the moth flies into and through the candle flame, it may only be scorched. It does not, however, learn wisdom, but the reaction is repeated so long as the moth can receive the light stimuli, so that the response, which in the average of cases is for the good of the race, destroys the individual under an environment which is different from that under which it was evolved. There is in this case no possibility of educating the individual. The race has to be educated to new conditions by the ruthless destruction of millions of individuals, until only those survive and impress their stamp on future generations whose machinery, by the accumulation and selection of minute variations, has undergone sufficient modifications to determine their automatic and "fatal" *avoidance* of the harmful stimulus.

The next great step in the evolution of our race was the modification of the nervous system which should render possible the education of the individual. The mechanism for this educability was supplied by the addition, to the controlling sensory ganglia of the head, of a mass of nervous matter which could act, so to speak, as an accessory circuit to the various reflex paths already existing in the original collection of nerve ganglia. This accessory circuit, or upper brain, comes to act as an organ of memory. Without it a child might, like the moth, be attracted by a candle flame and approach it with its hand. The injury ensuing on contact with the flame would inhibit the first movement and cause a drawing back of the hand. In the simple reflex mechanism there is no reason why the same series of events should not be repeated indefinitely, as in the case of the moth. The central nervous system, how-

ever, is so constituted that every passage of an impulse along any given channel makes it easier for subsequent impulses to follow the same path. In the new nerve center, which presents a derived circuit for all impulses traversing the lower centers, the response to the attractive impulse of the flame is succeeded immediately by the strong inhibitory impulses set up by the pain of the burn. Painful impressions are always predominant. Since they are harmful, the continued existence of the animal depends on the reaction caused by such impressions taking the precedence of and inhibiting all others. The effect therefore of such a painful experience on the new upper brain must far outweigh that of the previous impulse of attraction. The next time that a similar attractive impression is experienced the derived impulse traversing the upper brain arouses, not the previous primary reaction, but the secondary one, viz., that determined by the painful impressions attending contact with the flame. As a result, the whole of the lower tracts, along which the primary reaction would have traveled, are blocked, and the reaction—now an educated one—consists in withdrawal from or avoidance of the formerly attractive object. The burnt child has learned to dread the fire.

The upper brain represents a nerve mechanism without distinct paths, or rather with numberless paths presenting at first equal resistance in the various directions. As a result of experience, definite tracts are laid down in this system, so that the individual has the advantage not only of his lower reflex machinery for reaction, but also of a machinery which with advance in life is adapted more and more to the environment in which he happens to be. This educable part of the nervous system—*i. e.*, the one in which the direction of impulses depends on past experience and on habit—is represented in vertebrates by the cerebral hemispheres. From their first appearance they increase steadily in size as we ascend the animal scale, until in man they exceed by many times in bulk the whole of the rest of the nervous system.

We have thus, laid down automatically, increased power of foresight, founded on the law of uniformity. The candle flame injures the skin once when the finger is brought in contact with it. We assume that the same result will follow each time that this operation is repeated. This uniformity is also assumed in the growth of the central nervous system and furnishes the basis on which the nerve paths in the brain are laid down. The one act of injury which has followed the first trial of contact suffices in most cases to inhibit and to prevent any subsequent repetition of the act.

The Faculty of Speech.—If we consider for a moment the vastness and complexity of the stream of impressions which must be constantly pouring into the central nervous system from all the sense organs of the body, and the fact that, at any rate in the growing animal, every one of these impulses is, so to speak, stored in the upper brain, and affects the whole future behavior of the animal, even the millions of nerve cells and fibers which are to be found in the human nervous system would seem to be insufficient to carry out the task thrown upon them. Further development of the adaptive powers of the animal would probably have been rendered impossible by the very exigencies of space and nutrition, had it not been for the development of the power of speech. A word is a fairly simple motor act and produces a correspondingly simple sensory impression. Every word, however, is a shorthand expression of a vast sum of experience, and

by using words as counters it becomes possible to increase enormously the power of the nervous system to deal with its own experience. Education now involves the learning of these counters and of their significance in sense experience; and the reactions of the highest animal, man, are for the most part carried out in response to words and are governed by past education of the experience-content involved in each word.

The power of speech was probably developed in the first place as a means of communication among primitive man living in groups or societies; as a means, that is to say, of procuring cooperation of different individuals in a task in which the survival of the whole race was involved. But it has attained still further significance. Without speech the individual can profit by his own experience and to a certain limited extent by the control exercised by the older and more experienced members of his tribe. As soon as experience can be symbolized in words, it can be dissociated from the individual and becomes a part of the common heritage of the race, so that the whole past experience of the race can be utilized in the education—*i. e.*, the laying down of nerve tracts—in the individual himself. On the other hand, the community receives the advantage of the foresight possessed by any individual who happens to be endowed with a central nervous system which transcends that of his fellows in its powers of dealing with sense impressions or other symbols. The foresight thus acquired by the whole community must be of advantage to it and serve for its preservation. It is therefore natural that in the processes of development and division of labor, which occur among the members of a community just as among the cell units composing an animal, a class of individuals should have been developed, who are separated from the ordinary avocations, and are, or should be, maintained by the community, in order that they may apply their whole energies to the study of sequences of sense impressions. These are set into words which, as summary statements of sequence, are known to us as the laws of nature. These natural laws become the property of the whole community, become embodied by education into the nervous system of its individuals, and serve therefore as the experience which will determine the future behavior of its constituent units. This study of the sequence of phenomena is the office of science. Through science the whole race thus becomes endowed with a foresight which may extend far beyond contemporary events and may include in its horizon not only the individual life, but that of the race itself as of races to come.

Social Conduct.—I have spoken as if every act of the animal were determined by the complex interaction of nervous processes whose paths through the higher parts of the brain had been laid down by previous experience, whether of phenomena or of words as symbolical of phenomena. The average conduct, however, of the individual, determined at first in this way, became by repetition automatic—*i. e.*, the nerve paths are so facilitated by frequent use that a given impulse can take only the direction which is set by custom. The general adoption of the same line of conduct by all the individuals of a community in face of a given condition of the environment gave in most cases an advantage to those individuals who were endowed with a nervous system of such a character that the path could be laid down quickly and with very little repetition. Thus we get a tendency, partly by selection, largely by education, to the establishment of reactions which, like the instincts of animals,

are almost automatic in character. As MacDougall has pointed out, the representations in consciousness of automatic tendencies are the emotions. Moral conduct, being that behavior which is adapted to the individual's position in his community, is largely determined by these paths of automatic action, and the moral individual is he whose automatic actions and consequent emotions are most in accord with the welfare of his community, or at any rate with what has been accepted as the rule of conduct for the community.

Rise in Type dependent on Brain.—Thus, in the evolution of the higher from the lower type, the physiological mechanisms, which have proved the decisive factors, can be summed up under the headings of integration, foresight and control. In the process of integration we have not only a combination of units previously discrete, but also differentiation of structure and function among the units. They have lost, to a large extent, their previous independence of action and, indeed, power of independent action, the whole of their energies being now applied to fulfilling their part in the common work of the organism. At first bound together by but slight ties and capable in many cases of separating to form new cell colonies, they have finally arrived at a condition in which each one is absolutely dependent for its existence on its connection with the rest of the organism and is also essential to the well-being of every other part of the organism.

This solidarity, this subjection of all selfish activity to a common end, namely, preservation of the organism, could only be effected by a gradual increase in the control of all parts by one master tissue of the body, whose actions were determined by impulses arriving from sense organs which themselves were set into activity by coming events. We thus have with the rise in type a gradually rising scale in powers of foresight, in control by the central nervous system, and in the solidarity of the units of which the organism is composed.

In the struggle for existence the rise in type has depended, therefore, on the central nervous system and its servants. Rise in type implies increased range of adaptation, and we have seen that this increased range, from the very beginning of a nervous system, was bound up with the powers of this system. Whatever opinion we may finally arrive at with regard to the types of animals which we may claim as our ancestors on the line of descent, there can be no doubt that Gaskell is right in the fundamental idea which has guided his investigations into the origin of vertebrates. As he says, "the law for the whole animal kingdom is the same as for the individual. Success in this world depends upon brains." The work by this observer which has lately appeared sets forth in greater detail than I have been able to give you today the grounds on which this assertion is based, and furnishes one of the most noteworthy contributions to the principles of evolution which have been published during recent years.

We must not, however, give too restrictive or common a meaning to the expression "brains" used by Gaskell in the dictum quoted above. By this word we imply the whole reactive system of the animal. In the case of man, as of some other animals, his behavior depends not merely on his intellectual qualities or powers, to which the term "brain" is often in popular language confined, but on his position as a member of a group or society. His automatic activities in response to his ordinary environment, all those social acts which we ascribe in our-

selves to our emotions or conscience, are determined by the existence of tracts in the higher parts of his brain, access to which has been opened by the ruthless method of natural selection and which have been deepened and broadened under the influence of the pleasurable and painful impressions which are included in the process of education. All the higher development of man is bound up with his existence as a member of a community, and in trying to find out the factors which will determine the survival of any type of man, we must give our attention, not to the man, but to the tribe or community of which he is a member, and must try to find out what kind of behavior of the tribe will lead to its predominance in the struggle for existence.

Political Evolution.—The comparison of the body politic with the human body is as old as political economy itself, and there is indeed no reason for assuming that the principles which determine the success of the animals formed by the aggregation of unicellular organisms should not apply to the greater aggregations or communities of the multicellular organisms themselves. It must be remembered, however, that the principles to which I have drawn your attention are not those that determine survival, but those which determine rise of type, what I have called success. Evolution may be regressive as well as progressive. Degeneration, as Lankester has shown, may play as great a part as evolution of higher forms in determining survival. The world still contains myriads of unicellular organisms as well as animals and plants of all degrees and complexity and of rank in the scale of life. All these forms are subordinate to man, and when in contact with him are made to serve his purposes. In the same way all mankind will not rise in type. Many races will die out, especially those who just fall short of the highest type, while others by degradation or differentiation may continue to exist as parasites or servants of the higher type.

Mere association into a community is not sufficient to ensure success; there must also be differentiation of function among the parts, and an entire subordination of the activity of each part to the welfare of the whole. It is this lesson which we English-speaking races have at the present time most need to learn. In the behavior of man almost every act is represented in consciousness as some emotion, experience or desire. The state of subordination of the activities of all units to the common weal of the community has its counterpart in consciousness as the "spirit of service." The enormous value of such a condition of solidarity among the individuals constituting a nation, inspired, as we should say, by this spirit of service, has been shown to us lately by Japan. In our own case the subordination of individual to state interests, such as is necessary for the aggregation of smaller primitive into larger and more complex communities, has always presented considerable difficulty and been accomplished only after severe struggle. Thus the work begun by Alexander Hamilton and Washington, the creation of the United States, is still, even after the unifying process of a civil war, incomplete and marred by contending state and individual interests. The same sort of difficulties are being experienced in the integration of the units, nominally under British control, into one great nation, in which all parts shall work for the good of the whole and for mutual protection in the struggle for survival.

The Lesson of Evolution.—Just as pain is the great educator of the individual and is responsible for the laying down of the

nervous paths, which will determine his whole future conduct and the control of his lower by his higher centers, so hardship has acted as the integrator of nations. It is possible that some such factor with its attendant risks of extermination may still be necessary before we attain the unification of the British empire, which would seem to be a necessary condition for its future success. But if only our countrymen can read the lesson of evolution and are endowed with sufficient foresight, there is no reason why they should not, by associating themselves into a great community, avoid the lesson of the rod. Such a community, if imbued by a spirit of service and guided by exact knowledge, might be successful above all others. In this community not only must there be subordination of individual to communal interests, but the behavior of the community as a whole must be determined by anticipation of events—*i. e.*, by the systematized knowledge which we call science. The universities of a nation must be like the eyes of an animal, and the messages that these universities have to deliver must serve for the guidance and direction of the whole community.

This does not imply that the scientific men, who compose the universities and are the sense organs of the community, should be also the rulers. The reactions of a man or of a higher mammal are not determined immediately by impulses coming from his eyes or ears, but are guided by these in association with, and after they have been weighed against, a rich web of past experience, the organ of which is the higher brain. It is this organ which, as the statesman of the cell community, exercises absolute control. And it is well that those who predicate an absolute equality or identity among all the units of a community should remember that, although all parts of the body are active and have their part to play in the common work, there is a hierarchy in the tissues—different grades in their value and in their conditions. Thus every nutritional mechanism of the body is subordinate to the needs of the guiding cells of the brain. If an animal be starved, its tissues waste; first its fat goes, then its muscles, then its skeletal structures, finally even the heart. The brain is supplied with oxygen and nourishment up to the last. When this, too, fails, the animal dies. The leading cells have first call on the resources of the body. Their needs, however, are soon satisfied, and the actual amount of food or oxygen used by them is insignificant as compared with the greedy demands of a working muscle or gland cell. In like manner every community, if it is to succeed, must be governed, and all its resources controlled, by men with foreseeing power and rich experience—*i. e.*, with the wisdom that will enable them to profit by the teachings of science, so that every part of the organism may be put into such a condition as to do its optimum of work for the community as a whole.

At the present time it seems to me that, although it is the fashion to acquiesce in evolution because it is accepted by biologists, we do not sufficiently realize the importance of this principle in our daily life, or its value as a guide to conduct and policy. It is probable that this doctrine had more influence on the behavior of thinking men in the period of storm and controversy which followed its promulgation fifty years ago, than it has at the present day of lukewarm emotions and second-hand opinions. Yet, according to their agreement with biological laws, the political theories of to-day must stand or fall. It is true that in most of them the doctrine of evolution is invoked as supporting

one or other of their chief tenets. The socialist has grasped the all-importance of the spirit of service, of the subordination of the individual to the community. The aristocrat, in theory at any rate, would emphasize the necessity of placing the ruling power in the hands of the individuals most highly endowed with intelligence and with experience in the affairs of nations. He also appreciates the necessity of complete control of all parts by the central government, though in many cases the sense organs which he uses for guidance are the traditions of past experience rather than the science of to-day. The liberal or individualist asserts the necessity of giving to each individual equal opportunities, so that there may be a free fight between all individuals in which only the most highly gifted will survive. It might be possible for another Darwin to give us a politic which would combine what is true in each of these rival theories, and would be in strict accord with our knowledge of the history of the race and of mankind. As a matter of fact the affairs of our states are not determined according to any of these theories, but by politicians, whose measures for the conduct of the community depend in the last resort on the suffrages of their electors—*i. e.*, on the favor of the people as a whole. It has been rightly said that every nation has the government which it deserves. Hence it is all-important that the people themselves should realize the meaning of the message which Darwin delivered fifty years ago. On the choice of the people, not of its politicians, on its power to foresee and to realize the laws which determine success in the struggle for existence, depends the future of our race. It is the people that must elect men as rulers in virtue of their wisdom rather than of their promises. It is the people that must insist on the provision of the organs of foresight, the workshops of exact knowledge. It is the individual who must be prepared to give up his own freedom and ease for the welfare of the community.

Whether our type is the one that will give birth to the super-man it is impossible to foresee. There are, however, two alternatives before us. As incoherent units we may acquiesce in an existence subordinate to or parasitic on any type which may happen to achieve success, or as members of a great organized community we may make a bid for determining the future of the world and for securing the dominance of our race, our thoughts and ideals.

E. H. Starling

VACCINE THERAPY AND IMMUNIZATION

Two of the great hospitals of London, as we learn from the London *Times*, St. Mary's, at Paddington, and the Mount Vernon Hospital for Consumption, at Hampstead and Northwood, have recently issued appeals on behalf of their special funds for the study and practise of vaccine therapy and for the further development of immunization.

At the Mount Vernon Hospital the direction of the department has been committed to Dr. R. W. Allen, who has been directing his attention largely to affording protection against catarrh and influenza, and who will be applying the same principles to the treatment and, it may reasonably be hoped, to the cure of the forms of tuberculosis of the lung which are still confined to a somewhat limited area. In these, as in tuberculosis of the joints, there is every reason to expect the ultimate subjugation of the invading bacilli by the natural forces evoked through the agency of inoculations; but, in the one case as in the other, the demand for special resources arises from the fact that the application of the principle involved has not yet been brought within the scope of merely bedside observation, and must still be guided by laboratory work of a kind which occupies much time and

requires very special training and skill for its performance.

At St. Mary's Hospital the new department is being controlled and financed by a special committee, separate from and independent of that of the hospital itself, and many members of this committee have guaranteed large contributions for a period of seven years. Sir Ernest Cassel gives £1,000 a year for this period, besides having contributed over £800 towards the equipment of the laboratory. Mr. William Bonn gives £500 a year for two years and £250 a year for five years more. Lord Justice Fletcher Moulton gives £250 a year for seven years. Lord Iveagh and Major Henry Davis have each contributed £1,000 to equipment expenses, and many donations of smaller amounts have been received; but there is still room for more if the objects of the department are to be completely secured. The appeal from Mount Vernon is also for money, which will be carried to a separate fund as a provision for the totally new class of expense which will be incurred; but we have not yet been informed of the character of the response which has been made to it. The methods and principles concerned are practically the same in both cases; and it is probable that the form of disease which attacks the lung will not be left without many sympathizing contributors to an effort which seems to hold out renewed hope to a considerable proportion of those who suffer from it.

THE NUMBER OF STUDENTS IN THE RUSSIAN UNIVERSITIES

Professor B. Menschutkin, of St. Petersburg, writes to *Nature* in regard to the number of Russian students given by Professor Guido H. Marx in Science (May 14, 1909) as 23,000. He states that this number of students was reached some fifteen years ago, but at present the students of the higher colleges number at least 77,000, as can be seen from the following data, showing how many students there were in the different institutions in 1908 (in some cases, as for St. Petersburg, the numbers refer to the present year): *St. Petersburg* (University 9,800, Academy of Law 350, Philological Institute 150, Medical Academy 800, Technological Institute 2,000, Polytechnic Institute 4,200, Institute of Ways of Communication 1,200, Institute for Engineers 700, Electrotechnical Institute 650, Mining Institute 650, Institute of Forestry 550, the three higher colleges for women 6,000, Lyceum and three Military and two Nautical Academies 1,200, Academy of Theology 300), 28,550; *Moscow* (University 9,000, Institute of Oriental Languages 150, Academy of Theology 200, Technical Institute 2,500, Agricultural Institute 850, Engineering Institute 550), 13,250; *Kharkov* (University 5,300, Technological Institute 1,200, Veterinary Institute 500), 7,000; *Kiev* (University 3,200, Academy of Theology 200, Polytechnic Institute 2,500), 5,900; *Kazan* (University 3,000, Academy of Theology 170, Veterinary Institute 430), 3,600; *Tomsk* (University 800, Technological Institute 1,900), 2,700; *Warsaw* (University and Polytechnic Institute), 1,500; *Odessa* (University), 3,300; *Novocherkask* (Polytechnic Institute), 700; *Yuryev* (Dorpat) (University 3,000, Veterinary Institute 350), 3,350; *Helsingfors* (University 2,400, Technical College 350), 2,750; *Riga* (Polytechnicum), 1,700; *Novaya Alexandria* (Agricultural Institute), 400; *Yaroslavl* (Lyceum), 1,050; *Yekaterinoslav* (Mining Institute), 500; *Nězin* (Philological Institute), 150; *Saratov* (University, established this year), 200; *Vladivostock* (Institute of Oriental Languages), 300. The total number is therefore 76,900. There are also many private higher colleges in different towns, the number of students of which it is impossible to ascertain; it is surmised that this number is about 20,000.

SCIENTIFIC NOTES AND NEWS

On the occasion of the recent Leipzig celebration Dr. Wilhelm Wundt, the eminent psychologist, who made the principal address, was given the title of excellency. He was also made an honorary citizen of the city of Leipzig.

The University of Birmingham will confer on October 20 a considerable number of doctorates of laws to commemorate the recent visit of King Edward. Among the scientific men to receive the degree are Sir William

Crookes, Sir Archibald Geikie, Dr. J. S. Haldane, reader in physiology at the University of Oxford; Sir Joseph Larmor, Lucasian professor of mathematics in the University of Cambridge; Sir William Ramsay, Lord Rayleigh, Professor E. Rutherford, professor of physics in the University of Manchester; Professor Silvanus P. Thompson, Dr. W. A. Tilden and Sir J. J. Thomson.

MR. CHARLES B. DUDLEY, of Altoona, Pa., chemist for the Pennsylvania Railroad Company, has been elected president of the International Congress on Testing Materials, which has been in session in Denmark and will hold its next meeting in New York in 1912.

IT is announced in *Nature* that Dr. A. du Pré Denning, for several years lecturer in experimental physics in the University of Birmingham, and principal of the Municipal Technical School, Smethwick, has been appointed by the secretary of state for India to the newly-created post of superintendent of industries and inspector of technical and industrial institutions in Bengal.

RECENT visitors at the Bureau of Plant Industry of the U. S. Department of Agriculture have been: Dr. Oskar Loew, late of the Porto Rico Experiment Station, who is now *en route* to Germany; Dr. H. T. Güssow, botanist of the Central Experiment Station, Ottawa, Canada; Mr. Aaronshon, director of the Agricultural Experiment Station in Palestine. Mr. Aaronshon is engaged in preparing a report on the dry-land crops of Palestine.

PROFESSOR JUNIUS HENDERSON, curator of the University of Colorado Museum, spent the first half of the summer vacation on the California coast, collecting marine material, both recent and fossil, and shipped to the museum a large collection, especially rich in series showing variation of species. He spent the latter part of the season in northwestern Colorado with three assistants, collecting biological and paleontological material, which is to form the basis for a report on that region. Dr. Francis Ramaley and Mr. W. W. Robbins did a considerable amount of field work for the same institution at Tolland, Colorado, where the mountain botanical laboratory is situated, and Professor T. D. A. Cockerell brought back valuable collections from Europe, where he spent the summer.

MR. WILLIAM MARCONI reached New York on the *Caronia* last week.

CAPTAIN ROALD AMUNDSEN, the Norwegian explorer, has decided to postpone his projected expedition to the Arctic regions until June 1, 1910.

WE learn from *Nature* that the Scottish expedition to Spitzbergen under Dr. W. S. Bruce has arrived at Tromsö on board the steam yacht *Conqueror,* with all well on board. The expedition, which left Leith in July, is reported to have completed the survey of Prince Charles Foreland and made important geological and other investigations.

LIEUTENANT SHACKLETON will give an account of his antarctic exploration in a series of lectures to be given in German and Austrian cities during the month of January next.

MISS MARIA PARLOA, born in Massachusetts in 1843, died at her home in Bethel, Conn., on August 21. She was widely known as a teacher and lecturer on cookery and other home economic topics. A careful observer, she contributed much which is of value to the science of food and nutrition. In addition to her popular lectures she gave instruction at schools and special work on the preparation of food for medical students. She was the author of many books and magazine articles on cookery and home economic topics, as well as of government bulletins on nutrition. She was a pioneer in the home economics movement in the United States in both its educational and practical sides and influential in introducing such subjects into the public schools.

M. L. BOUVEAULT, assistant professor of organic chemistry at the Sorbonne, Paris, has died at the age of forty-five years.

THE deaths are also announced of Professor V. F. Kremser, of the Berlin Meteorological Institute; of Dr. Franz Meschede, formerly professor of psychiatry at Königsberg, and of Dr. Fritz Erk, honorary professor of meteorology at Munich.

DR. BRUNHUBER and Dr. Schmitz, German explorers, have been murdered by the primitive tribes on the Upper Salwin, in western Yunan.

THE meeting of the American Physical Society for November 26 and 27, 1909, will be held in the new physics building of the University of Illinois, at Urbana-Champaign, Illinois.

THE American School Hygiene Association and the American Physical Education Association meet with the Department of Superintendents of the National Education Association in Indianapolis during the last week of February, 1910.

THE Third International Congress on School Hygiene is announced for Paris from March 29 to April 2, 1910.

THE International Esperanto Congress, which has been meeting in Barcelona with an attendance of 1,300 delegates, has decided to hold its next session at Washington during August, 1910.

THE select committee of the House of Commons has presented a report adverse to the daylight saving bill.

THE daily papers state that a natural bridge spanning 274 feet and over 300 feet high, said to be the largest known, has been discovered by members of the Utah Archeological Society, which has returned from an expedition along the Colorado River in northern Arizona and southern Utah. The bridge is situated four miles north of the Arizona line in the state of Utah, six miles east of the Colorado River.

To encourage the photographing of the Leonids under favorable atmospheric conditions the Treptow Observatory, near Berlin, offers three prizes, the first of which is a telescope worth $40. The photographs must be made from a balloon, during the time from November 13 to 16, 1909, and the competition is open to the citizens of all nations. The original negatives awarded the prizes, together with all rights of publication, become the property of the illustrated periodical *Das Weltall*, published by the Treptow Observatory.

WE learn from *Nature* that a movement has been started to unite entomologists in a congress entirely devoted to entomology in its various aspects, and to establish a permanent committee which may act as a central organization in the interest of this subject. It is proposed that a congress of entomology be held every three years, about a fortnight before each triennial zoological congress, so that resolutions and conclusions of general importance could, if deemed necessary, be brought up for discussion at the ensuing zoological congress. The first International Congress of Entomology will be held on August 1–16, 1910, at Brussels, during the International Exposition, which will be taking place there at that time. The subjects to be brought before the general or sectional meetings will comprise systematics, nomenclature, anatomy, physiology, psychology, ontogeny, phylogeny, ecology, mimicry, etiology, bionomy, paleontology, zoogeography, museology, medical and economic entomology. It will be remembered that the eighth International Congress of Zoology is to be held next year at Graz, Austria.

UNIVERSITY AND EDUCATIONAL NEWS

THE University of Pennsylvania proposes to erect during the coming year a building for its graduate school, costing $250,000.

BEREA COLLEGE receives $5,000 by the will of Dr. William P. Wesselhoeft, of Boston.

MR. WILLIAM E. MOTT, associate professor of hydraulic engineering of the Massachusetts Institute of Technology, has been elected to take charge of the department of civil engineering at the Carnegie Technical Schools, Pittsburgh.

MR. HEATON B. ROBERTSON has been appointed instructor in mining and metallurgy in the Sheffield Scientific School of Yale University. In the same university Mr. Harry H. Wylie has been appointed assistant in psychology.

DR. JACOB KUNZ has been elected assistant professor of physics of the University of Illinois. Dr. Kunz is a graduate of the University of Zurich, and was for several years Privatdocent in mathematical physics in

Zurich. Later he spent a year in Cambridge with Professor J. J. Thomson. His courses at the University of Illinois will be in theoretical physics.

THE following are the new appointments in the scientific departments of the University of Kansas: Frederick E. Kester, professor of physics and head of the department; George C. Shaad, professor of electrical engineering and head of the department; Harry Gardner, assistant professor of sanitary engineering; Roy L. Moodie, assistant professor in zoology; Wilhelmina Bauer, instructor in mathematics; Jas. T. Bowles, instructor in pharmacy; H. J. Broderson, instructor in chemistry; Paul V. Faragher, instructor in chemistry; Arthur B. Frizell, instructor in mathematics; Meyer Gaba, instructor in mathematics; Florence Hedger, instructor in chemistry; Chester A. Johnson, instructor in physics; Nadine Nowlin, instructor in zoology; Howard A. Parker, instructor in civil engineering; George N. Watson, instructor in pharmacy; Paul Wernicke, instructor in mathematics; Bert C. Frichot, laboratory assistant in chemistry; Clifford P. Johnson, assistant instructor in physiology; C. A. Nash, assistant instructor in chemistry; E. R. Weidlein, assistant instructor in chemistry; Edward Wiedemann, assistant instructor in bacteriology.

A CHAIR of physical chemistry and metallurgy has been established at Frankfort to which Dr. Lorenz, of Zurich, has been called.

DISCUSSION AND CORRESPONDENCE

THE COUNTRY BOY

IN SCIENCE for July 2 Dr. Frederick Adams Woods replies to my article of May 7. I am very glad to learn from this article of Dr. Woods that we are not so far apart as I had suspected. I had thought that he claimed that practically heredity had everything and environment very little indeed to do with the development of character. Evidently I have misunderstood him, for in the article in question he indicates clearly that he believes that environment may produce profound results in character. Dr. Woods misinterprets part of what I said, or at least he does not get the idea which I meant to convey. Perhaps the fault is entirely my own. What I meant to say was that the environment of royalty is such as to give an opportunity for the full development of the natural tendencies of the individual and, therefore, in this class of people heredity will more nearly account for intellectual ability and moral character than it will in those classes of society who do not live under an environment that will give full opportunity for the development of the natural bent of the individual.

Since the publication of my last article I have been able to collect some data which is of interest in connection with the effect of farm life on the growing boy, and while these data are meager they seem to me to be favorable to the assumption that if other things could be equalized the life of the farm has a very distinct educational value. Dr. Woods has shown that at the time when the average man noted in "Who's Who" was a boy, about 16 per cent. of our population lived in the cities. He further showed that about 30 per cent. of the individuals in "Who's Who" were brought up in the city. He accounts for this excess of city men amongst men of note by the fact that the city attracts talent, the percentage of ability in the city, therefore, being greater than in the country. He would, therefore, explain the excess of city men mainly as the result of heredity. He may be correct in this position. I am inclined at present, however, to believe that while this excess may be partly due to the fact that talent is attracted to the city and that, therefore, the city child has a better chance of inheriting talent, part of it is due to the fact that the cities in general have better school facilities than the country. Most of the men in "Who's Who" are those who had good educational advantages. I suspect, therefore, that if an adequate study were made we should find that in this case environment has had something to do with the fact that 30 per cent. of the men in "Who's Who" are from the city. But for the sake of argument let us accept Dr. Woods's point of view. It would then follow that 30 per cent. of our leading men should be accredited to the city if their leadership is due entirely to heredity. Now for the facts in the

case. It is recognized that the following statistics are meager and that conclusions can only be drawn from them tentatively, but the fact that the figures are consistent with each other confirms their correctness. The following table gives statistics for the three classes of men who may be, perhaps, placed highest amongst the list of our leading men:

Class of Men	City	Country and Village	Per Cent. from Country
Presidents	2	23	92.0
Governors	4	41	91.2
Cabinet officers ...	9	47	83.9
Totals	15	111	88.2

The figures for presidents include all the presidents this country has had. Of course in the early days a smaller proportion of our population lived in the cities. But this criticism can not be applied to the list of governors. Figures for this class of men relate to the present governors of the states. It is seen that 91.2 per cent. of this class of men are from the country or village. The figures for cabinet officers include members of cabinets between 1869 and 1903. The average of these three classes of men shows 88.2 per cent. of them from the country. Now, if we accept Dr. Woods's view that the cities furnish a larger proportion of our leading men for the reason that talent is attracted to the city, the proportion of these men coming from the country should be considerably less than the proportion of our population in the country, but the facts show that the proportion of these men from the country is actually greater than the proportion of country population. This seems to me to argue strongly for farm life as an educational force. In the case of governors, of the forty-five who answered my queries four were born and reared in the city, seven of them in country villages and thirty-similar data for the other classes.

I have received replies from forty-seven railway presidents in this country. Of these 55.4 per cent. are credited to the village and country. When we remember that preferment in this industry is greatly influenced by hereditary wealth it seems to me that the fact that so large a percentage of these men are country bred is somewhat significant. Statistics for members of the house of representatives are of less value for our present purpose than most of the other statistics given here, for the reason that nativity is a distinct force in politics, and that many representative districts are wholly city while others are wholly country districts. Sixty-four per cent. of the present members of the house of representatives are from the country. Figures for members of the senate are of more value in this respect, since senators represent states. Yet the fact that most of our senators are very wealthy men would seem to justify the inference that the city has more than its share of this class of men, yet 70.6 per cent. of the eighty-five members of the present senate for whom data could be obtained are from the country. Taking all six of these classes of men, the average per cent. from the country is 69.4. It will be noted that the higher we go in the scale of leadership in those classes which are least influenced by extraneous considerations, the higher is the per cent. of country-bred men. I believe these figures substantiate the claim made in my original article, namely, that country life has a distinct educational value. But what is it in country life that gives this advantage? President Lucius Tuttle, of the Boston and Maine Railroad, in answering my circular letter answers this question. He says:

> Among other things, the farm boy learns methods of economy and, incidentally, the value of money. He is a part of the business machinery of the farm and is brought into close contact with all its affairs. He learns methods of trade and how to buy and sell, as well as possible, without incurring losses and, later on when he leaves the farm and goes into a general business, the education he has acquired during his farm life becomes a fundamental and valuable part of his after business life.
>
> As a general rule, the city boy has no connection with his father's business and knows nothing about it. His father may be eminently successful but the boy has nothing to do with making his success and is very seldom allowed to be cognizant of the methods of business his father uses. Under modern conditions, school life gives the boy very little business knowledge and, at the end of his

school education, when he enters business, he is obliged to begin at the bottom of the ladder without knowledge of many things that the farm boy has learned in connection with his daily home life.

To my mind this is the fundamental reason why boys brought up on the farm appear to make better successes in their after business life than do city boys who have not had the advantages of a similar business training in their earlier days.

President White, of the Richmond, Fredericksburg and Potomac Railroad Company, in discussing the effect of life on the farm, says:

It is preeminently, in my judgment, an experience which develops independence and self-reliance and, therefore, I think, the spirit of achievement, more than any other I know of.

Another railroad president remarks:

I believe that farm life lays a good and broad foundation for a healthy, vigorous manhood in both mind and body.

Another noted railway man, who never spent a day on the farm, says:

I am inclined to think boys brought up on the farm have better constitutions and are less liable to temptations.

President L. W. Hill, of the Great Northern Railway, says:

My present home is on a farm and my principal reason for making my home there, rather than at some of the lakes or in the city, is that I have three boys of my own I am trying to give a fair start in life. I believe there is no end of arguments that living on the farm gives the best chance for a growing boy. While my making the farm my home sometimes works an inconvenience to me, I realize that the benefits to my children are well worth the inconvenience to me of getting in and out between my office and the farm.

I have always contended that the value of farm rearing lies in the fact that on the farm there is a chance to place responsibility on the growing boy. I firmly believe that it is possible to work out a system of education that will give our schools all the advantages of the farm life. This is being done, to a certain extent, in the cities, and I believe that this fact has something to do with the increasing number of strong men who come from the city. But I must admit that the actual data on this subject are very meager and I join Dr. Woods in the hope that some careful student will give this question the investigation which its importance demands. W. J. SPILLMAN

U. S. DEPARTMENT OF AGRICULTURE

DOCTORATES CONFERRED BY AMERICAN UNIVERSITIES

I REGRET to find that several errors were made in compiling the statistics of the doctorates conferred by American universities (SCIENCE for August 20). The number of degrees conferred by Wisconsin was sixteen (not seven), of which four were in the sciences. There were five degrees (not three) in geology conferred by Yale with geology as the major subject. On page 266, column 2, line 4, Michigan should be substituted for Washington. The assistant who compiled the data is not without excuse for these errors; for example, in the case of Wisconsin the doctorates conferred are given in two different places on the commencement program without any cross references. But I regret the occurrence of errors in statistics which I believe have hitherto been free from them.

J. MCKEEN CATTELL

THE NOMENCLATORIAL COURT

TO THE EDITOR OF SCIENCE: Some weeks ago Mr. Francis N. Balch called attention in the columns of SCIENCE to the need of a court for determination of questions in zoological nomenclature. It appears that the International Congress of Zoologists has appointed a Nomenclature Commission of which Dr. C. W. Stiles, of Washington, is secretary, which performs the functions of such a court although its work is still far from being well developed or appreciated.

It appears that the International Congress has not made any appropriation for the expenses of this court whose labors have hitherto been carried on as a work of love. As the business before the court has accumulated the need of a paid clerk becomes urgent. As I understand the International Congress has no means of raising funds for the carrying on of the business of its committee, it is obviously the duty of those who most directly profit by the activities of the committee to pay a tax

for the salary of such a clerk. I understand from Dr. Stiles that $1,200 would pay for the salary of a clerk. I would suggest, therefore, that ten of the leading Museums of the United States pay each $60 toward this expense and that $60 be paid by ten museums of Europe. Those in America to be the National Museum and those at Cambridge, Boston, New York, Brooklyn, Philadelphia, Pittsburgh, Chicago, Milwaukee, San Francisco. It would, of course, have to be recognized that this charge would be an annual one.

If the great museums of this country would thus voluntarily pay such a tax, the court of reference for questions of zoological nomenclature would become permanently established.

CHAS. B. DAVENPORT

SCIENTIFIC BOOKS

Igneous Rocks. By JOSEPH P. IDDINGS. Vol. I., Composition, Texture and Classification. 8vo, xi + 464 pages, 130 figures and two colored plates. New York, John Wiley & Sons. 1909.

It is not often that a work appears in the literature of any science which stands out so clearly from other corresponding works in respect to both its point of view and its intrinsic value that it must be accorded the rank of epoch making. But such is the fact in the writer's opinion concerning the volume by Professor Iddings which is the subject of this notice. Here is a treatise on igneous rocks which does not in the least pattern after the numerous works on the subject, but from the outset follows a new plan. The author has studied the igneous rock with the aid of modern developments in physics and chemistry and makes the understanding of composition and texture in the light of those developments the all-important thing.

The point of view of the author may be in a measure inferred from the order in which the properties of igneous rocks are presented, and the manner in which they are discussed in Part I., on Composition and Texture. The igneous rock is, of course, the product of the consolidation of a molten magma. The fundamental property which the rock shares with the magma from which it was derived is its chemical composition. Hence the work presents in Chapters I. and II. the characteristic facts as to the chemical composition of the rocks and of their constituent minerals. Groups of rock analyses are given and a full statement of the various devices used by petrographers to represent in diagrams the significance of the varying amounts of different components shown by analysis. Two colored plates represent many hundred analyses by means of diagrams of Iddings's own design.

A departure from the usual procedure in discussing the chemical composition of rock minerals is made by taking up the chemical elements known to occur in rocks and, considering them in groups of Mendeléeff's table, indicating the mineral into which they are likely to enter under the associations and restrictions of the case.

The fact that an igneous rock is derived from highly complex molten solution by crystallization is to the author abundant reason for insisting that the petrographer should understand the principles of physics and chemistry applicable to rock magmas and Chapter III. is devoted to this subject. Special attention is given to the properties of magmas as solutions, and to the chemical reactions which may take place under certain conditions in solutions, expressed in the terms of modern physical chemistry.

Following this general discussion is one in which the chemical reactions likely to take place in rock magmas under the conditions prevailing in the crustal zone of the earth are particularly considered. Taking the thirteen constituents which are prominent in most igneous rocks the controlling influence of relative chemical activity, strength of combination, affinity of certain elements for each other, and the effect of differing proportions of the elements, are considered in their bearing on the formation of observed rock minerals. To a large extent the reasons for the abundance of certain mineral molecules and the rarity of others containing the same substances are plain. The laws which control the common association of some minerals, the apparently antithetical relations of others, and the de-

velopment of rare combinations are discussed.

In Chapter V. Iddings gets at the meat of the matter as to the formation of the rock from the magma. The rock is formed by the separation of solid, liquid and gaseous substances from the magma, crystallization of minerals being the principal process. This change from the magmatic solution to the solid rock may take place in one or several periods, at one or several levels in the crust of the earth or at the surface. The conditions under which different stages of consolidation take place are constantly changing, not only from the circumstances of environment incident to eruption but from the changes connected with partial crystallization and various disturbances of chemical equilibrium. It is beyond the limits of this notice to review this important chapter in detail and an enumeration of the principal headings must suffice to show the method of treatment.

The separation of gases, liquids and solids is discussed. Under the latter the principal causes of separation are considered—such as the addition or loss of substances, lowering of temperature and changes of pressure. Saturation and supersaturation as influenced by changes in temperature, and the metastable and labile conditions of solutions, are treated in sections. Then comes the discussion of Number of Points of Separation, The Rate of Separation, The Effect of Viscosity on the Rate of Separation, Polymorphic Substances, The Order of Separation, Effect of Supersaturation on Order of Separation, Separation of Isomorphous Compounds, Zonal Structure and Eutectic Mixtures of More Than Two Compounds.

The author refers to the subject-matter of this chapter in these words:

> From the foregoing it appears that the solidification with crystallization of rock magmas must be an extremely intricate process, involving variable or irregular changes in temperature and pressure consequent on the movements of eruption, together with variations in composition chiefly through changes in gaseous components, and the possibilities of chemical reaction among the components with changing chemical equilibria, and the probabilities of supersaturation of the magma by different components to various degrees.

The origin of mineral composition of the rock having been discussed, there is taken up, in Chapter VI., the question of crystallization and resultant texture. Here again the treatment logically consists in showing the effect of a great range of changing or variable conditions in determining texture. After discussing the genesis of the formal relations of the parts of a rock Iddings describes the textures of igneous rocks under the divisions Crystallinity, Granularity and Fabric, using the terms which have recently been proposed[1] to supplement the inadequate terminology in current use. The illustrations used in this chapter are particularly good and tend to emphasize the desirability of greater precision and refinement in the description of igneous rock textures.

Differentiation of Rock Magmas is the subject of Chapter VII. The evidences of differentiation are first presented with regard to the visible relations of parts of a single rock mass on the one hand, and as exhibited by many relations which connect the various rocks of a petrographic province on the other. Having established by the citation of facts that the petrographer must recognize in various rock series or groups the products of differentiation from a parent magma, Iddings proceeds to the discussion of processes and hypotheses concerning them. It is notable that this discussion is sane and conservative. The author advocates no hypothesis or speculation without a plausible basis in the laws of physics and chemistry, which has sometimes been done by prominent leaders in the science. On the contrary, the conditions which have been operative on the magmatic solution at various stages of its history are examined to find influences which may have led to differentiation, of different degrees and kinds. The effects of changes in density, viscosity, molecular concentration and saturation, are discussed, to show that they may under certain circum-

[1] "The Texture of Igneous Rocks," by Cross, Iddings, Pirsson and Washington, *Jour. Geol.*, Vol. 14, 1906, pp. 692–707.

stances favor differentiation. Instances in nature which seem to be explainable by these processes are cited. Contemporaneous veins and pegmatic veins are considered by Iddings as resulting from differentiation and a hypothetical explanation for each is given. The facies of composition and texture exhibited by many igneous masses are examined in their relation to differentiation.

The solution of rock by liquid magma is considered, with the conclusion that evidences of this absorption within the zone available to our examination are rare. Hybrid or mixed rocks are given a brief mention, and a concise historical review of hypotheses of differentiation is given. In a short but interesting sketch of the course of magmatic eruption Iddings shows some of the phases or periods which may be supposed to favor magmatic differentiation.

The last chapter of Part I. is devoted to a description of the modes of occurrence of igneous rocks. Here the course of treatment naturally follows that of other treatises. Numerous excellent and new illustrations add greatly to the attractiveness of this chapter.

Part II. of the volume deals with "Nomenclature and Classification," truly a most difficult subject at the present time. On many sides one may hear expressions of extreme dissatisfaction with the existing condition of systematic petrography and its terminology. But we are in a perfectly natural, though most uncomfortable, stage in the evolution of the science. The man who understands the essence of the igneous rock, as presented by Iddings, can best comprehend that nomenclature and classification to-day are in confusion because it could not be otherwise.

Iddings first reviews the growth of the prevalent nomenclature and of the classifications it expresses. The facts are familiar to petrographers and they are presented by the author in a way to emphasize the conclusion that with such a history the existing confusion is simply the logical result.

In one chapter Iddings sketches the prevalent system—if system it can be called—under the term "Qualitative Mineralogical System." For the presentation of this system Iddings has recourse to the usual tabular scheme, inserting the names to be defined in their appropriate spaces. Then follows a definition of each name in terms of mineral composition and texture. These definitions are essentially as they may be found in the works of Rosenbusch and Zirkel, except the expression of genetic ideas attached by the former. These same names are used with similar signification by German, French, English, American and other petrographers in spite of more or less different bases of classification.

In the final chapter of the volume Iddings presents a statement of the "Quantitative Classification of Igneous Rocks" of which he is a co-author.[2] Here is given a criticism of the qualitative mineralogical system and a discussion of the available bases of classification, leading to the choice of chemical composition as the foundation of the quantitative system. This follows closely the original presentation of the system, but is accompanied by many references to facts brought out in earlier parts of the book.

Taken as a whole this volume leads directly to the quantitative system as the only one yet devised by means of which the petrographer may adequately and correctly express the relations of igneous rocks in regard to their absolute, determinable properties as objects. The discussion of the origin of mineral composition and texture is certainly thorough enough to demonstrate the author's deep interest in petrogenesis, but it also serves to show that the complexities, if not the uncertainties, of genetic relations render them unavailable as bases of a truly systematic classification of all igneous rocks.

The work is written from a standpoint occupied to some extent by other specialists, but which must henceforth be familiar ground to every petrographer worthy of the name. Not that one must agree with Iddings in all respects, but that the study and the scientific discussion of igneous rocks must be based on

[2] "Quantitative Classification of Igneous Rocks," by Cross, Iddings, Pirsson and Washington, The University of Chicago Press, 1903.

the fullest recognition of the extremely complex magmatic solutions from which they have come and of the varied conditions determining the characters of the rocks themselves, and not infrequently producing rocks of different mineral composition from a single magma.

This volume is a treatise on igneous rocks which is manifestly an unfettered expression of the author's understanding of them rather than a text-book. Yet it outlines so logically the view of these objects which the student should be made to understand that it may be used as the basis of instruction in all advanced courses.

The book appears in uniform style with "Rock Minerals" by the same author. The second volume, descriptive of known rocks, is in preparation, and will be awaited with interest and with the hope that the author may be successful in making his subject more attractive than is the case with existing literature of the kind.

WHITMAN CROSS

Railroad Structures and Estimates. By J. W. ORRUCK, C.E. New York, John Wiley & Sons. 270 pages, 94 illustrations. $3 net.

Probably the primary purpose of this book is to furnish data for estimating the various parts of a railroad, and it contains a compilation of cost data which should prove of value to many a young engineer, not only in furnishing reasonable figures of costs, but also in stimulating him to secure similar figures for his own locality or from his own railroad. Costs vary from time to time and also locally, so that figures for estimates can not safely be swallowed whole either from this book or any other. A book of this sort then should find its best value in suggesting methods of cost estimation, and in analyzing the constituent parts of costs. This book is somewhat uneven from this standpoint, some chapters having the elements of cost well classified, while others are very general, as in the costs of tunnels where a short table of costs per lineal foot is quoted from Drinker's rather ancient treatise; while the estimates for turnouts are itemized, the cost of a split switch is given as $30 to $50; and similarly for laying and surfacing it, $30 to $50; a variation of considerable amount without special explanation to account for it. The criticism applies perhaps to the difficulty of the subject rather than to inferiority of treatment.

The compilation of cost data involves a knowledge of the structures or materials to be built or used; as a result a large share of the book is given to such descriptions, or sometimes practically specifications. There are given, also, a number of tables which seem hardly consistent with the general purpose of the book; among these are one "for putting in frogs and switches," others for "feet head and equivalent pressure in pounds per square inch," "friction of water in pipes," "friction of water in elbows"; also a table of "horse-power."

The chapter on buildings, covering eighty-eight pages, is quite largely given to descriptions, and these cover many classes of buildings; it has not quite the merit of a treatise and yet any one is likely to find there some thing he wants and which is worth while. In the estimates of this chapter, some are well analyzed and itemized, while some others are very general and with wide range of cost values, a freight shed with modern floors being estimated at 25 to 50 cents per square foot.

The chapter on Specifications and Contracts, covering thirty-one pages, is inadequate, and except for four pages on estimates, hardly in line with the apparent purpose of the book.

The book in its mechanical make-up has the general appearance and quality of the Wiley books on engineering, which means that it is satisfactory. The scope is indicated by the following Chapter Index:

I. Track Materials. II. Fences, gates, sign posts. III. Culverts. IV. Bridges. V. Buildings. VI. Water Stations. VII. Tanks. VIII. Specifications and Contracts. IX. Estimating Notes.

C. F. ALLEN

Neuere Ergebnisse auf dem Gebiete der Speziellen Eiweisschemie. PROF. EMIL ABDERHALDEN. Jena, Verlag v. Gustav Fischer.

"Die Neueren Ergebnisse auf dem Gebiete

der Speziellen Eiweisschemie" first appeared as a chapter in the "Handbuch der Biochemie" edited by Karl Oppenheim. The entire subject of proteins was treated in that "Handbuch" by several authors, and it was the part of Professor Abderhalden to present that phase of the progress in protein-chemistry which was made possible through the new analytical and synthetical methods, introduced by Emil Fischer.

Professor Abderhalden was a close associate of Emil Fischer during the time when the work was in progress and that makes the chapter more vivid and authoritative than any other on the subject of protein chemistry, written for the Oppenheimer Handbuch.

The work on protein chemistry of Fischer and his school falls into two large groups: one which brought to light the elementary components of the protein molecule, and the second, which elucidated the character of their linkage in the protein molecule. The first was in its nature principally analytical, the second synthetical. The work in either direction was preceded by a careful study of the properties of some derivatives of aminoacids. In course of this study Fischer introduced an improvement into the method of Curtius for preparing the ethylesters of the aminoacids from their hydrochlorides. This made possible the distillation of the esters and their separation one from another in a convenient, neat and comparatively rapid manner. The part assigned by Fischer to Abderhalden and his coworkers was to apply this process to the separation of the aminoacids obtained on the cleavage of nearly every protein known in nature. A part of the book contains a complete and concise account of all this work.

The property of the esters of the aminoacids to form anhydrides of the acids was the basis for the synthetic formation of peptides. It is safe to say that this discovery was the most important phase in the development of protein chemistry, since it contained the key to our knowledge of the manner in which individual aminoacids are linked in the protein molecule.

The original method of peptid synthesis was later improved through the introduction of the halogenacyl synthesis which led to the formation of optically active peptides. This new achievement in its turn opened the way to the study of the configuration of peptides and of the relation of configuration to the action of proteolytic enzymes. The book of Abderhalden gives a complete account of all these achievements in a very concise form. The properties of all known aminoacids and their derivatives are described in a manner which makes the work serve as a valuable reference book. The analytical methods are also described, though not always in minute detail. All this makes the book very serviceable to the investigator, and at the same time it gives a good survey of the development of our knowledge of the chemical structure of the protein molecule. The physical properties of the proteins and the character of their primary cleavage products are not discussed by Abderhalden.

P. A. LEVENE

THE ROCKEFELLER INSTITUTE
FOR MEDICAL RESEARCH

SCIENTIFIC JOURNALS AND ARTICLES

THE opening (October) number of volume 16 of the *Bulletin of the American Mathematical Society* contains the following papers: "Note on Fermat's Numbers," by J. C. Morehead and A. E. Western; "An Extension of Certain Integrability Conditions," by J. E. Wright; "Necessary Conditions that Three or More Partial Differential Equations of the Second Order shall have Common Solutions," by C. A. Noble; "Note on Determinants Whose Terms are Certain Integrals," by R. G. D. Richardson and W. A. Hurwitz; "On the Tactical Problem of Steiner," by W. H. Bussey; "On the So-called Gyrostatic Effect," by A. S. Chessin; "A Continuous Group related to Von Seidel's Optical Theory," by A. C. Lunn; "Shorter Notices": Runge's Analytische Geometrie der Ebene, by M. Bôcher; Netto's Gruppen- und Substitutionentheorie, by W. B. Fite; Czuber's Einführung in die höhere Mathematik, by C. L. E. Moore; Ball-FitzPatrick's Recréations mathématiques, by D. E. Smith; Pockel's

Lehrbuch der Kristalloptik, by E. B. Wilson; "Notes"; "New Publications."

SPECIAL ARTICLES

ON MAGNETIZATION BY ANGULAR ACCELERATION

Some time ago, while thinking about the origin of the earth's magnetism, it occurred to me that any magnetic substance must, according to current theory, become magnetized by receiving an angular velocity.

Thus consider a cylinder of iron or other substance constituted of atomic or molecular systems whose individual magnetic moments are not zero. The simplest ideal system of this kind is of course a negative (or positive) electron revolving about a positive (or negative) center. In its initial state the magnetic moment of the cylinder composed of all the systems is zero. If, however, it is given an angular acceleration about its axis, the resulting torque on each individual system will cause its orbit to change its orientation, or the revolving part its speed, in such a way as to contribute a minute magnetic moment parallel to the axis of the cylinder, all the systems, if alike, contributing moments in the same direction. If the revolving electrons are negative, as appears at least generally to be the case, the cylinder will become magnetized as it would be by an electric current flowing around it in a direction opposite to that of the angular velocity imparted to it.

Early in July I began some experiments on this subject, using slightly modified apparatus constructed originally for other purposes. These experiments appear to show the effect in question in the case of a large steel rod, the intensity of magnetization resulting when an angular speed of about 90 revolutions per second was produced being about $1/1500$ c.g.s. unit, in the direction indicated by theory on the assumption that the revolving electrons are negative. This effect, if substantiated by later work, will account for a minute part of the earth's magnetism, but, apparently, for only a minute part. It is the converse of the effect which has been looked for recently by Richardson.

Superposed on this effect was another, perfectly definite and unquestionable, but exceedingly difficult to account for, viz., a magnetization along the rod in a definite direction independent of the direction of rotation and of the direction of the original residual magnetism of the rod. It was not due to the jarring of the cylinder as it was rotated in the earth's field, nor to a possible minute change in the direction of its axis produced by the pull of the motor. In magnitude this effect was several times as great as the other, which became manifest only at the higher of the two speeds used.

The observations were made inductively with a ballistic galvanometer. The throws were very small, but definite, and were in opposite directions for starting and stopping.

Later on I hope to investigate this subject more thoroughly with apparatus designed for the purpose. I am sending this account to you because of the importance of one of the effects mentioned, and the fact that some months must elapse before a thorough investigation can be undertaken.

S. J. BARNETT

August 5, 1909

NITRIFYING BACTERIA IN NORTH CAROLINA SOILS

IN a recent number of SCIENCE[1] Stevens and Withers present some interesting data concerning the existence in North Carolina of non-nitrifying soils. It was pointed out that 71 per cent. of 62 soil samples representing, with few exceptions, normal agricultural soils near the North Carolina Agricultural Experiment Station failed to nitrify, a state of affairs considered anomalous.

At the time of the publication of this paper the Laboratory of Soil Bacteriology of the Bureau of Plant Industry was receiving a number of soil samples from fields or plots where legume inoculation experiments were in progress. Thirty samples from crimson clover fields in North Carolina (representing nineteen counties) were submitted to a test for nitrification. Seven samples were from the Piedmont Plateau and twenty-three from the coastal-plain region.

[1] SCIENCE, N. S., XXIX., No. 743, p. 506.

The method used consisted in determining the amount of ammonium sulphate the soil would convert into nitrate during an incubation of eight days. The soils were first spread out on a clean sheet of paper and allowed to become air dry, being carefully protected against dust during this time. To 50 grams of this soil was then added a quantity of 0.4 per cent. ammonium sulphate (about 5 c.c.) sufficient to bring the moisture content to (or a little below) the optimum for plant growth.[3] No tests were carried on in solutions, it having been our experience that nitrifying bacteria do not act normally in test solutions. This fact has also been reported by Stevens and Withers.[4] The amount of nitrates found minus the amount originally found in the soil represents the action of nitrifying bacteria on the ammonium sulphate solution.

The table shows the nitrates found by this method to have been formed in thirty North Carolina farm soils.

Six tests of soil samples from other localities are included for comparison. It will be seen that while our results substantiate the point that nitrification is at a rather low ebb in North Carolina soils, yet nitrifying bacteria are generally present, and if supplied with suitable food would undoubtedly soon multiply sufficiently to cause a normal rate of nitrification.

A comparison of samples nos. 7 and 8 is interesting: no. 7, having a low nitrifying power, was from a portion of a field where crimson clover formed no nodules, and the soil gave a pink reaction; no. 8, showing fairly active nitrification, was from another portion of the same field, gave no reaction to litmus, and root nodules occurred in average numbers. This is typical of much unpublished data upon soils from other regions and leads us to believe that nitrification, nodule formation upon certain species of legumes, and the litmus reaction are correlated.

NITRIFICATION IN NORTH CAROLINA SOILS

No.	Locality. Post-office in North Carolina	Nitrate in Original Sample. p.p.m.	Nitrate Formed in Eight Days from Ammonium Sulphate. p.p.m.
1	Cameron	trace	40
2	Dunn	25	100
3	LaGrange	trace	62
4	Roseboro	"	125
5	Richfield	60	125
6	Ahoskie	12	110
7	Wilson	0	20
8	Wilson	0	82
9	Salemburg	0	40
10	Gates	trace	75
11	Shine	"	98
12	Fayetteville	1	33
13	Pisgah	trace	75
14	Hobbsville	"	50
15	Farmville	"	50
16	Hayesville	"	50
17	Durham	"	60
18	Farmville	"	80
19	LaGrange	1	77
20	Sandy Ridge	trace	1
21	Jamesville	1	125
22	Haynes	0	95
23	Ayden	0	34
24	Roxobel	trace	25
25	LaGrange	4	150
26	Pink Hill	trace	59
27	Ashboro	"	42
28	Tarboro	0	1
29	Moretz	trace	102
30	Gatesville	"	32
31	Lanham, Md.	"	300
32	" "	"	100
33	" "	"	500
34	" "	"	225
35	Edgerton, Kan.	160	400
36	New Cambria, Mo.	80	500

KARL F. KELLERMAN,
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WASHINGTON, D. C.

[3] The samples were placed in salt-mouth bottles stopped with a wet plug of cotton to maintain even moisture conditions, and were incubated eight days at 30° C. Distilled water (100 c.c.) was then added to the soil, bottles shaken for fifteen minutes, allowed to settle, filtered, and the clear solution tested by the phenol-disulphonic acid method, as described in Bureau of Soils Bulletin No. 31, p. 40.

[4] SCIENCE, N. S., XXVII., No. 704, p. 991.

SECOND ANNUAL SPRING CONFERENCE OF THE GEOLOGISTS OF THE NORTH-EASTERN UNITED STATES

ON April 23 and 24 a conference of the geologists of the northeastern United States was held in Philadelphia, Pa., at the invitation of the Mineralogical and Geological Section of the Academy of Natural Sciences. Two sessions for pre-

sentation of papers were held on the first day, and a field trip to typical localities of the pre-Cambrian and early Paleozoic rocks of the region on the second day. After an address of welcome by Dr. Edward J. Nolan, secretary of the academy, seven papers were read, as follows:

The Lower Cambrian of Lancaster County, Pa.: H. Justin Roddy, State Normal School, Millersville, Pa.

The rocks of the Lancaster Valley comprise quartzite, argillite and limestone, in all of which abundant fossils have recently been discovered, including many of the typical forms of the Olenellus fauna. The argillites, in particular, contain magnificently preserved examples of *Olenellus thompsoni* and *Holmia walcotti.* No Middle or Upper Cambrian fossils have as yet been found, but the limestones are overlain on the north by shales of "Hudson River" type, at the base of which traces of Ordovician forms have been observed. Because of complicated structure, the thickness of the Lower Cambrian is not certainly known, but it probably exceeds 3,000 feet.

The Pre-Cambrian Gneisses of the Pennsylvania Piedmont Plateau: Miss Bascom, Bryn Mawr College.

Of the crystalline rocks of this district the gneisses present the more serious difficulties in the determination of age, origin and stratigraphic relations.

There has been determined the following succession of pre-Cambrian gneisses: hornblende gneiss, granite gneiss, Wissahickon mica gneiss, Baltimore gneiss.

The Baltimore gneiss, underlying the Paleozoic series, to the lowest member of which it has furnished débris, exhibits two facies: a massive facies presumably of igneous origin and a sedimentary facies peripheral in position.

The Wissahickon mica gneiss exhibits many facies, due to the injection and impregnation of a sedimentary formation of somewhat varying composition, but always characterized by an excess of mica. This gneiss is adjacent to, or overlying the Paleozoic series, but is considered to be separated from them by a thrust fault for the following reasons:

1. While the gneiss persists over great areas, the adjacent Paleozoic series change from one member of the series to another and in the thickness of single members.

2. The gneiss shows a coarser crystallization than the adjacent Paleozoics. It is contrasted with the Ordovician mica schist, a formation of similar composition with which it is in contact for long distances, from which the gneiss can always be separated by a greater degree of metamorphism and by structure.

3. The Wissahickon gneiss, like the Baltimore gneiss, is thoroughly intruded by chonoliths of granite, gabbro, pyroxenite and peridotite, which are not found intruded in the Paleozoics.

The hornblende and granite gneisses are manifestly igneous in origin, intrusive in character and younger than the other gneisses.

The Medina and Shawangunk Problems in Pennsylvania: A. W. Grabau, Columbia University.

The Formation No. IV. of the Pennsylvania Surveys is not all of the same age, as formerly supposed, but comprises two entirely distinct groups of formations. The lower of these includes the Bald Eagle conglomerate, well exposed in the westernmost of the Appalachian ridges, which is of Upper Ordovicic, approximately of Eden age; the Juniata red-beds, corresponding to the Queenstown shales of western New York, of late Lorraine and Richmond age; and the Tuscarora sandstone, the equivalent of the true Medina, marking the base of the Siluric. In the easternmost of the ridges, the Blue Mountain, the conglomerate is the Shawangunk, which is known to be of Salina age; and this is followed by the Longwood shales and they in turn by the Lewistown limestone, which is uppermost Siluric. The conglomerates and shales are believed to be of continental origin, representing the alternation of torrential deposits with flood plain and æolian deposits under semi-arid climates. Their geographical distribution shows them to have the form of great alluvial fans, deposited by rivers flowing from the southeast; and the occasional intercalated fossiliferous beds represent the temporary advance of the sea upon the margins of the fans.

The Buried Gorge of the Hudson River: W. O. Crosby, Massachusetts Institute of Technology.

Glacial Erosion in Great Britain, France and Switzerland: Douglas Wilson Johnson, Harvard University.

This paper discussed two questions: (1) Are hanging tributary valleys a reliable indication of glacial erosion of the main valley? (2) May not hanging tributary valleys result from glacial *widening* of the main valley, instead of from glacial *deepening?* It was shown that while the formation of hanging valleys by normal stream

erosion is possible under certain conditions, the occurrence of hanging valleys of this type is exceptional, and their peculiar origin may be detected by associated physiographic features. It was concluded that in general hanging tributary valleys of the common type are to be regarded as proof of glacial erosion. A study of the relations normally existing between stream valleys and their tributaries proves that hanging tributary valleys of any length can hardly be produced by glacial widening of the main valley, and that where such hanging valleys exist a significant amount of glacial over-deepening must be inferred. A method of estimating the actual amount of glacial over-deepening of valleys with a fair degree of accuracy was described, and the application of this method to glaciated valleys in Europe was discussed. Glacial over-deepening amounting from 600 to over 1,000 feet was found to have occurred in three of the valleys studied.

On the basis of this study it was concluded that no account of drainage modifications in glaciated regions could be regarded as complete if it failed to take account of the possible changes due to glacial erosion. The relation of this study to the drainage problems in western New York, and to engineering problems in the gorge of the Hudson River, was briefly touched upon.

The Early Paleozoic of the Lehigh Valley District, Pennsylvania: Edgar T. Wherry, Lehigh University.

Contrary to the usual opinion, it has been found that the Cambrian and Ordovician portions of the Great Valley limestones in this district can be readily distinguished on a lithologic basis, five formations being recognizable between the Hardyston quartzite of Lower Cambrian age and the Martinsburg shale of Lower Trenton to Utica age, as follows (local names being provisionally applied, and the thicknesses roughly estimated): Leithsville formation, Lower-Middle Cambrian, gray dolomite with abundant sandy and cherty layers, and buff-colored shale beds, 1,500 feet. Allentown limestone, Upper Cambrian, white to gray, dolomitic, largely oolitic, full of Cryptozoon, 2,000 feet. Coplay limestone, Beekmantown, dark gray, shaly, with mottled crystalline layers, numerous fossils, 1,500 feet. A marked erosion interval occurs here, so that the whole thickness of the Coplay is rarely seen. Nisky formation, Black River, gray, very shaly limestone, probably never exceeding 100 feet in thickness. Nazareth cement rock, Lower Trenton, varying from 500 feet or more down to zero, being replaced westward and southward by the Martinsburg shale. The presence of two small areas of Shawangunk conglomerate, preserved by down-faulting some twenty miles south of the main exposure in the Blue Ridge, corresponding in position and lithologic character to the Green Pond of New Jersey, is also announced.

Characteristics of the Older Crystallines of Southeastern New York: Charles P. Berkey, Columbia University.

There are but three well-established formations belonging to the completely metamorphosed series of the vicinity of New York City. These are:

(*a*) Fordham gneiss and its associates (oldest).
(*b*) Inwood limestone.
(*c*) Manhattan schist (youngest).

The Fordham gneiss and Manhattan schist are not always readily distinguished. Certain varieties of each are alike in every essential character, and if the evidence is confined to these varieties no determination can be made. This is especially true of the intrusive members.

A study of thousands of cases where discrimination between these two formations was necessary has convinced the writer that the most constant characters of the Manhattan schist in order of importance are:

(*a*) The presence of a white pearly mica.
(*b*) Coarse foliation.
(*c*) A crumpled structure.

And in contrast the most constant Fordham gneiss characters are:

(*a*) A banded structure.
(*b*) Close granular or granitoid texture merging into foliation.
(*c*) Abundance of feldspathic constituents.

During the past year a study of Manhattan Island, especially the covered portion of the southern third, and adjacent areas southward on Long Island, has been made by means of an examination of all drill borings whose materials could be seen—several hundred in all. Discrimination by the above criteria indicates a much more complex structure and areal distribution than formerly mapped. Both gneiss and limestone are represented in these southerly areas. Recent borings placed for the purpose of testing this structure have proved the case beyond any question by penetrating both of these formations at points indicated by this interpretation.

Edgar T. Wherry,
Secretary

SCIENCE

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

AMERICAN STANDARDS IN EDUCATION AND THE WORLD-STANDARD[1]

FOR the most part, higher education in America has been carried on by institutions singularly isolated one from another. Each has been a law unto itself. The state has conferred upon them academic powers, but has not defined their academic responsibilities. In a little less degree, the same separatism has prevailed in our secondary education, and again in less degree in our elementary schools.

We were individualists in our education, with institutions as our units, before we became out-and-out individualists, with single students as our units. It is hard to see how this individualism could now be carried further, unless it might be by extending the elective system down through the grades and into the primary school. The most radical advocates of free election, however, balk at the offer to six-year-olds of a choice between learning to read and learning to make mud pies. Here at least the doctrine of equivalence breaks down, and indeed it seems doubtful whether the elective system will spread very far beyond its present boundaries. Its great vogue in our best universities, its long ascendency, the personal weight of its ablest advocates —even these considerations can not disguise the fact that, in the long sweep of educational history, it is a mode, a fashion, a phase, and not the ultimate solution of a problem of the ages. In more trivial and

[1] Address of the Vice-president and Chairman of Section L. Baltimore, 1908.

irreverent speech, such a phase is commonly called a fad.

The most of our so-called educational fads are at least half true. We believe in them with all our hearts until they run into their inevitable exaggerations. All of us here to-day undoubtedly believe in the elective system, and we can never go back to the educational views and practises which that system has displaced. But we recognize the fact that it embodies somewhat less than the whole truth regarding an educational curriculum. In other words the utter disorganization of studies can not be taken as the final stage in the history of studies. It is rather a wholesome and necessary preliminary to a better and more humane organization.

It is a significant fact that, just at the time when the elective system is attaining its widest acceptance and our scholastic individualism is reaching its utmost limit in the studies of collegiate students, a new movement toward institutional coherence is setting in among our schools and universities. The first decade of the twentieth century seems destined to be a turning point in the history of common educational standards in this country. I should like to point out some of the characteristic features of this new movement, and to show that it can not stop short of becoming a world-movement.

It is fair to say that we have not been without standards in our earlier educational history, however vague and inadequate those standards may have been. The most definite and appreciable mark of scholastic competence which we have had within our own borders has been the degree of bachelor of arts, as conferred by our better colleges. The four-year course of these colleges has represented our conception of the measure of liberal culture attainable by any considerable number of our citizens, and the entrance requirements of these same colleges has been our norm for secondary education.

Such a standard, informally accepted by the country at large, might serve the purpose reasonably well while we were getting our systems of elementary and higher education for the first time into working order. Its inadequacies became manifest when we deliberately set about combining higher education and elementary education into one national and democratic system. And those inadequacies were accentuated when we found ourselves deliberately combining general education with special education, the liberal with the vocational, to provide a full-orbed preparation for the life of our time.

There were many ways in which such inadequacy appeared. One of the most baffling elements in the situation was found in the fact that our ready-made system provided no method for determining what were the really standard colleges. Harvard and Yale were the names that came most readily to the lips. But common report could not be deemed sufficient to decide the question when the actual and tangible interests of other widely scattered institutions and of their alumni were at stake. Even if Harvard and Yale were accepted without question as embodying the American standard, there was no obvious and adequate procedure by which other institutions could be measured up against them. And Harvard and Yale had differences of their own.

Some of the first steps toward the definition of a standard other than that of a single institution were taken by certain states, in the prescription of conditions governing the incorporation of colleges. Inasmuch as the power to grant academic degrees is by common consent in this country a power derived directly from the

state, this method of fixing a standard within state limits has been available from the beginning. But the states have been slow to apply it. The state of New York, in its university of the commonwealth, has had at hand the apparatus for making effective a legal provision touching this matter. With its growing sense of the possibilities of this organization, in recent years, it is not strange that New York has led the way in the making of definite requirements for degree-giving institutions.

The university law of 1892 authorizes the regents of the University of the State of New York to incorporate educational institutions and provides that no institution shall be given power to confer degrees in the state of New York unless it shall have resources of at least $500,000 and shall have suitable provision, approved by the regents, for buildings, furniture, educational equipment, and proper maintenance. Among the ordinances adopted by the regents under this enactment is one which provides that

An institution to be ranked as a college must have at least six professors giving their entire time to college and university work, a course of four full years of college grade in liberal arts and sciences, and must require for admission not less than the usual four years of academic or high-school preparation or its equivalent, in addition to the pre-academic or grammar-school studies.

An act of the legislature of Pennsylvania approved June 26, 1895, provides that no institution of learning shall be given power to grant degrees until the merits of the application from an educational standpoint shall be passed upon by a College and University Council created by the act. The act further provides that

No institution shall be chartered with the power to confer degrees, unless it has assets amounting to five hundred thousand dollars invested in buildings, apparatus and endowments for the exclusive purpose of promoting instruction, and unless the faculty consists of at least six regular professors who devote all their time to the instruction of its college or university classes, nor shall any baccalaureate degree in art, science, philosophy or literature be conferred upon any student who has not completed a college or university course covering four years. The standard of admission to these four-year courses or to advanced classes in these courses shall be subject to the approval of the said council.

Where there is present a state university of high grade, this institution can be made to serve as a rough-and-ready measure for the state. This is what was done in California, where the definite need of a scale of requirements arose when the licensing of teachers for public high schools was separated from similar provision for the elementary schools.

The provision referred to was enacted in 1893 and provides that no credentials for high school certificates shall be prescribed or allowed unless the same, in the judgment of the state board of education, are the equivalent of a diploma of graduation from the University of California. This law, therefore, makes of the state board a body for the classification of higher institutions, with the university of the state as the standard of measurement.

In 1907 the state educational board of examiners of Iowa were granted authority to accept graduation from the regular and collegiate courses in the state university, state normal school, and the state college of agriculture and mechanic arts, and from other institutions of learning in the state having regular and collegiate courses of equal rank, as evidence that a teacher possesses the scholarship and professional fitness for a state certificate. They were authorized also to validate certificates from other states where such certificates were issued upon scholarship and experience equivalent to that required under the laws of Iowa.

While such provisions as these have been adopted in a few of the states, there have

been numerous beginnings made in the past few years, by educational boards and associations of wider scope, to set up standards in different portions of the educational field.

The Association of Collegiate Alumnæ, which was organized in 1882, admits to its membership graduates of institutions whose work and equipment have been approved by the Association. Inasmuch as the association deals only with institutions to which women are admitted, its scope as a standardizing body is limited to colleges for women and coeducational institutions. The standard adopted by this Association has not been published and is understood to be in process of revision.[2]

The Association of American Universities was organized in 1900 for the purpose of considering matters of common interest relating to graduate study. Among the important items mentioned in the invitation to the conference which resulted in the formation of the Association was the consideration of means to secure in foreign universities "such credit as is legitimately due to the advanced work in our own universities of high standing." The initial membership of the Association consisted of fourteen universities. At the present time there are eighteen members.[3]

In 1906 a committee was appointed by this body to report on the aim and scope of the Association. The committee's report was made and unanimously adopted at the meeting at Ann Arbor, Michigan, in January, 1908. It recommended that in addition to a strong graduate department, which had previously been the sole condition of membership in the Association, there should be adopted as a second criterion for membership the requirement of one or more years of college work as a prerequisite for admission to professional courses, the combination being so arranged that no professional degree should be given until the satisfactory completion of at least five years of study.

In order that no substantial hardship might be imposed by a strict enforcement of both requirements at the present time, the committee recommended that in universities which have professional schools and a graduate department, the graduate department shall at least be creditable, and that the arts and technical work prescribed for professional degrees in at least one professional school shall be not less than five years. The Association undertook, through a special committee, to make a list of the colleges of the country whose degrees are to be regarded as of equal value with the college degrees conferred by members of the Association.

The College Entrance Examination Board was organized in 1900 to bring about as rapidly as possible an agreement upon a uniform definition of each subject required by two or more colleges for admission; to hold or cause to be held a series

[2] Since this paper was written the Association of Collegiate Alumnæ has published a revision of its standard. Summarized briefly the conditions for eligibility to membership include entrance requirements demanding at least four years of secondary school work; graduation requirements corresponding to amount of work ordinarily included in four years of serious college study; the number of full professors, total property, and productive endowment shall not be less than the minimum in institutions already admitted to membership; the ratio of full professors to students and of instructors to students, number of laboratories, number of books in the library and number of departmental journals shall be at least as large as the average number in institutions of the same type already admitted to membership; no preparatory department shall be under the government or instruction of the collegiate faculty; the salaries of the teaching staff shall not be lower than the minimum for the same grade in institutions already admitted to membership where the living conditions are similar.

[3] This number was increased to twenty-two at the annual meeting held in January, 1909.

of college admission examinations, with uniform tests in each subject; and to issue certificates based upon the results of such examinations. The constitution of this Board provides that a college or university may, upon application, be admitted to its membership, provided that in the college applying for admission:

(1) There shall be specifically defined and consistently carried out, whether by examination or certificate (or for the admission of special students), requirements for admission which shall in every case be equivalent to a four-year course in a college-preparatory or high school of good grade, able to prepare its pupils for admission to the colleges already belonging to this Board. (2) The members of the faculty shall have an academic training adequate to maintain a high standard of teaching; they shall bear a proper proportion to the students to be taught, and shall be sufficient in number to permit of proper specialization in the subjects assigned to each individual instructor. (3) The breadth of the college curriculum, the standard of graduation, the grade of work and the amount of work demanded, shall be proper subjects of inquiry by the Executive Committee, and shall constitute factors in determining their decision. (4) There shall be no preparatory department under the government or instruction of the college faculty. (5) There shall have been for at least three years preceding the application for admission an average of at least fifty students in the regular entering classes (courses in arts and in science to be reckoned together for this purpose). (6) There shall be a free income-bearing endowment yielding in no case less than twenty thousand dollars annually, or in the case of state universities and colleges an equivalent annual appropriation from public funds, expended exclusively on the undergraduate department; as well as libraries, laboratories, buildings and equipment adequate to maintain the degree of efficiency and the standard of scholarship contemplated in the above provisions.

The Carnegie Foundation for the Advancement of Teaching was created in 1905 for the purpose of administering a fund for pensioning college professors. Its governing board adopted, in April, 1906, regulations fixing an educational standard for the institutions which should be counted as eligible to participate in the benefits of this fund. The definition of a college adopted by the Foundation is practically that in use by the regents of the University of the State of New York. It is stated in the following terms:

An institution to be ranked as a college must have at least six professors giving their entire time to college and university work, a course of four full years in liberal arts and sciences, and should require for admission not less than the usual four years of academic or high school preparation, or its equivalent, in addition to the pre-academic or grammar-school studies.

A technical school to be eligible must have entrance and graduation requirements equivalent to those of the college, and must offer courses in pure and applied science of equivalent grade.

To be ranked as a college an institution must have a productive endowment of not less than two hundred thousand dollars.

Because of its ability to give or withhold valuable grants, and its declaration that these grants will be made only to institutions of a certain academic grade, and further because of adequate provision in the office of the Foundation for the investigation of all institutions applying for such grants, this establishment has become one of the most powerful agencies for clearing up and unifying our standards in higher education. It is doubtful whether all of the agencies working directly to this end, taken together, have thus far accomplished so much in the fixing a norm of collegiate education in this country as has been done, under far-sighted direction, in the short term of its activity hitherto, by the Carnegie Foundation.

The National Conference Committee on Standards of Colleges and Secondary Schools is an outgrowth of two annual conferences of delegates from a number of the associations of colleges and preparatory schools of the country, the first of which was held at Williamstown in 1906. At the third annual meeting of delegates from

these several associations in April, 1908, the National Conference Committee[4] was organized. It adopted a resolution urging the organizations represented in the committee to collect data concerning the standardization of colleges and universities and to give special attention to the study of this subject.

The National Association of State Universities appointed a committee on standards of American universities in November, 1905. A report was presented to the Association in November, 1908, which included the following recommendations: That the standard American university be defined as an institution which requires for admission the completion of a standard four-year high school course or its equivalent; which offers two years of general or liberal work; which offers a further course of two years so arranged that the student may begin work of real university character leading to the bachelor's degree at the end; which offers professional courses in law, medicine and engineering, based upon the completion of two years of college work; and which offers in the graduate school an adequate course leading to the Ph.D. degree.

Thus far attention has been called to the steps which have already been taken by states and by various national bodies, toward a better determination of the grade of our collegiate institutions. In addition to these acts and resolves, some notable efforts have been made to fix the standards of our professional education. Two instances of unusual significance may be noted here.

In 1904 the American Medical Association created the Council on Medical Education to act as its agent in efforts to elevate the standards of medical education. This Council holds an annual conference and makes recommendations concerning the improvement of medical education, which recommendations are then presented to the Association. It has classified the medical colleges of the country according to the percentage of failures of graduates of these colleges before state medical examining boards; it has published lists of medical colleges making certain admission requirements; and it has proposed what is held to be an ideal scheme of medical education.

The National Association of Dental Examiners was organized in 1883. It has formed a list of reputable dental schools, which list is revised from year to year. It works in close relations with the National Association of Dental Faculties, in the endeavor to advance the standards of dental education. Many difficulties have attended this undertaking and its history is full of interest.

This is by no means a complete list of the agencies now engaged in the effort to give at least an ascertainable significance. But as it stands the showing is noteworthy. It leaves no doubt that widespread and serious attention is now directed to this subject. The reproach against our American education that it means anything or nothing according to circumstances, is not merely resented or ignored, nor is it merely accepted as inevitable. Steps are taken to remove the sting from that reproach by making it no longer applicable. We see more clearly the difficulties of our situation, but we see also the hope of

[4] The committee consists of delegates from The New England Association of Colleges and Preparatory Schools; New England College Entrance Certificate Board; Association of Colleges and Preparatory Schools of the Middle States and Maryland; College Entrance Examination Board; North Central Association of Colleges and Secondary Schools; Association of Colleges and Preparatory Schools of the Southern States; National Association of State Universities, and Carnegie Foundation for the Advancement of Teaching. The United States Commissioner of Education is *ex officio* a member.

remedy. For now some fifteen or twenty years the movement toward a betterment has been going on, but its more definite and encouraging developments belong mainly to the new century.

The question can now be fairly put to the legislatures of the several states: Is it just and right to incorporate institutions for the instruction of our people and authorize them to give academic degrees and certificates, with no provision for determining the meaning and worth of those scholastic labels? It is not merely an academic question. It is a moral question. False pretenses in the realm of education are a peculiarly flagrant form of fraud, for they cheat our American youth of their American right to a fair chance. They operate no less disastrously when the fraud is unconsciously committed, that is, when incompetent teachers and school authorities offer an inferior grade of instruction under the delusion that it is as good as the best. The well-meaning no less than the dishonest need some impartial test by which their educational offering may be proved, of what sort it is.

The pure-food agitation has undoubtedly lent new point to this standardizing movement. It has strengthened the conviction that the public is entitled to know what it is getting, in a matter that vitally affects human health and human life. It is extremely difficult to devise and carry into effect a plan that will secure such publicity without doing violence to personal rights. But since these difficulties have not proved insurmountable in the case of foods and drugs, we have courage to believe that the greater difficulties attending a standardizing of education will not prove insurmountable. There is even more of human welfare at stake in the case of education than in the former case.

It should be said at this point that to adopt a standard does not mean to bring all institutions up to an actual level. Even if that were possible, it would not be desirable. A new institution in a sparsely settled region, for example, may fairly aim at being ultimately a university, and yet may render its best service through all of its earlier years by maintaining only a good secondary or preparatory school. Whether it shall follow this course or not is a local question, to be determined in accordance with local needs. But if its real high school is allowed to stand as a make-believe college, we have a case of false pretenses, and grievous wrong is done the state, the community, and, most of all, the students of the school. Another illustration comes to me in a personal recollection. The head of a law school, himself a thoroughly trained university man, once told me of the standing of his school. Its requirements for admission were lower than those of the best law schools, but were distinctly announced for what they were. Its requirements for graduation were less severe than those of leading schools, but they were clearly stated and strictly enforced. The faculty was made up of competent men, each of whom gave to the school only a part of his time, but gave regularly what was announced as his part. Summing up, my informant said to me, "This is not a first-class school. It does not pretend to be. But it is a first-rate second-class school. I find a need for a law school of this grade in the community and we are meeting that need."

I can conceive that in many communities there may be some need that can best be met by a second-class school. But if that school declares itself to be what it is and makes itself a first-rate school of its class, it may render an honorable service to the community and may even be a force making for righteousness.

We have had two or three notable instances of late of institutions which have deliberately renounced the name of *university* to take the more modest title of *college* or *institute*. The training school for teachers which I attended in my youth was burdened by law with the title *state normal university*. It made no pretense, however, of being a university, and I well recall hearing its downright president declare repeatedly before the assembled students, "This is not a college. It is a normal school."

It is, then, the moral gain that is the chief good to be had from a clear definition of our standards. But other advantages, too, are obvious. For many institutions, to define their standard is to raise their standard, and this is gain, save in the few instances where the higher standard may represent requirements that are really excessive. The possibility of measuring the work of institutions even far remote from the centers of population and culture, will give needed encouragement to groups of devoted teachers who are worthy of such encouragement. Small and isolated colleges will gain new hope of winning and holding each a local constituency, and so of making strong local centers of science and cultivation, when their claims to academic competence can be fairly tested and approved.

There are two further advantages which call for special emphasis, one of them material and the other in the nature of sentiment. Where common standards are widely understood and applied, the graduate of a given institution will find no difficulty, even in remote parts of the land, in securing recognition for his scholastic credentials. This is of especial importance when those credentials have to do with his occupation in life, as is the case with teachers, physicians, and those engaged in other professional pursuits. Even where the practise of the profession is guarded by regular examinations, a professional diploma is important, as establishing the holder's *prima facie* claim to recognition. It is desirable, too, that our diplomas and professional certificates may become so clear in their meaning and so reliable as regards the conditions on which they are issued, that they may safely take the place of professional examinations, or at least of the more elementary and vexatious portions of such examinations. The lack of comity as between the several states with regard to the practise of the professions is one of the extremely unsatisfactory conditions affecting our professional life at the present time. We can not accept this condition as necessary. It can undoubtedly be remedied. But the remedy lies in making the meaning of our academic and professional credentials at least an ascertainable datum. Here is a consideration, having serious relation to our material needs, which strongly accentuates the movement we are reviewing.

Then the sentimental consideration. Our state pride and our institutional loyalty are both of them factors in our real and effective life. But our state pride suffers when we find the schools of our state disparaged or even discredited by comparison with those of other states; and our loyalty to our own institution, even if it be of no higher grade than that which goes by the name of "college spirit," insists that our college shall not fall below the grade of the best colleges in the land. The comparison is inevitably made with what is believed to be the best in other parts of our common country. A national standard is recognized even when it can not be clearly set forth. And the state or the institution which undertakes to grade its own educational performance without reference to that national standard soon suffers embarrassment and eventually suffers a positive disadvantage and loss, both for itself and for its graduates.

What has been said thus far with reference to the imperative need of national standards as a corrective of merely local and provincial standards, leads up, I believe inevitably, to the view that no national standard can be adequate or stable until it has been consciously referred to the world-standard of our time. In endeavoring to establish American standards, we must not stop short of this ultimate step, the critical comparison of the standards proposed for our own land with those recognized by the rest of the civilized world. Otherwise we shall simply have passed from one provincialism to another—a broader, more conspicuous, and therefore more glaring—provincialism.

It may be said of the world-standard in education, as was said of the national standard, that it is already in existence, but only dimly apprehended as yet. There is so much of free intercourse between the culture-nations of the modern world, that a comparison of scholastic ideals and processes is continually going on. An important section of our current educational literature is devoted to such comparisons. But these comparisons are still for the most part unsystematic and fragmentary. The attempt has hardly been made as yet to determine to what extent a consensus of international opinion has already been reached in any of the central questions involved, or what sort of agreement is attainable by conference and by the systematic interchange of instructors, students, and practitioners in the several professions.

It would be an interesting academic exercise to trace the gradual and unnoticed development of this international standard since the time when modern nationalism replaced the cultural unity of the medieval world. We may be sure that such an investigation would bring many surprises. But our present problem is practical rather than historical. The same needs and forces which have made the question as to national standards a pressing and vital question, are operative to-day on the international plane. Within the past three years this question has repeatedly come before the Department of State at Washington, on representations from officials of our diplomatic and our consular service. American citizens—physicians, dentists, candidates for higher degrees in foreign universities—have repeatedly found themselves at a disadvantage owing to the lack of a basis for comparison of their scholastic credentials with the requirements of those foreign countries of which, for the time, they are residents. It is not generally known how delicate and embarrassing are some of the difficulties which have been encountered in this field, and how little progress has yet been made toward a satisfactory adjustment of those difficulties.

Not only the practical exigencies of the case, but national sentiment as well, must prompt us to seek for such provisions as shall place the products of American education on a basis of fair comparison with those of other great educational systems. In so far as our works suffer by the comparison, they should be improved. In so far as the comparison places us in an unfavorable light because of a misunderstanding of what we are actually accomplishing, we must see to it that our system shall be more adequately set forth. Our educational relations with the rest of the world can never be on a satisfactory basis till we are in a position to do our full part in determining what the world-standard shall be.

We do not seek to prescribe standards for the rest of the world. We are not willing that the rest of the world should simply prescribe standards for us. But we do seek to gain and maintain an acknowledged position among the foremost culture nations, such that our influence shall not

be less than that of any other people in determining what shall be the universally recognized norms of scholastic competence.

In this discussion I would not blink either the difficulties or the dangers of the standardizing movement. The dangers are many and real, chief among them that of imposing on our educational institutions a flat uniformity, which would take no account of wholesome individualities nor of provision for local and special needs. This is a serious danger, even where the standard is imposed by influence only, and not by authority. The difficulties of the situation, too, are vastly greater than any superficial inquiry would reveal. The chief of these is the difficulty of finding criteria by which the real effectiveness of educational systems may be measured. Certain time measures most readily present themselves—the number of years in the course, the hours of instruction per week, the number of students per teacher, the years of special training which the teachers themselves have enjoyed. These are obviously inadequate, yet they serve a useful purpose. They measure the skeleton and so reveal the stature of a course of education. But more subtle measures are needed to measure the flesh and blood and spirit of instruction, that which gives it its power and human significance. And how shall we ever gauge that finer inspiration which makes of some schools a center of creative and re-creative energy!

Incalculable differences there must always be even among schools and systems that are classed together. But the need for some working estimate of comparative values remains and can not be put aside. Even a rough measure of the stature of institutions of learning will serve a purpose and such a measure is urgently required in these days.

It is clear that the question of equivalence among widely different materials and processes must enter into this problem. It is a question which presents great difficulties, both theoretical and practical. Yet some rough-and-ready estimate of equivalence has long been made in the highest educational institutions. Wherever the degree of Doctor of Philosophy is bestowed, for work done and not *honoris causa*, a common designation has been applied to the most various attainments. The substance has been largely ignored in the bestowal of this degree, and attention has been directed instead to the mastery of method. Where so great divergence has been allowed without loss of essential unities, it would seem possible that recognition can be freely extended to widely different educational systems, even if those differences be international, without renouncing all claim to a common and lofty standard.

This is one point for which we of the United States will undoubtedly have to contend in any world-concert as regards education. We are committed to a fair range of individuality in education, both institutional and personal. We do not assume in advance that any form of education is inferior because it is different from others. And we can not permit the rest of the world to judge any part of our education as inferior simply because it is different. Probably a majority of marked variations will prove to be of inferior quality; and others that are on their way to the highest excellence will seem inferior for a time, until their character is fully established. But with us the variant is to be welcomed and given its fair chance, for our system is always alive to the hope of far-reaching improvement. We shall be able to justify this attitude before the rest of the world so far, and only so far, as our educational achievement in general shall show a sustained and appreciable excellence.

The argument comes to this, that our American endeavors to set up definite edu-

cational standards can not be permanently successful till they are fully related with the larger movement, the movement toward the determination of world-standards.

It has been necessary to limit this discussion by taking account only of higher and professional education. The movements of the time, however, relate as well to education of secondary and elementary grade, and some of their most interesting results may be looked for on those lower and broader fields. But as professional and higher instruction must in some measure determine the bounds of all instruction, it is natural that, as an international question, we should have first to do with standards in these departments of teaching. The bachelor's degree, the doctorate in philosophy and science, and the certificate of competence to practise medicine, are pivotal points as regards the international question.

The devising of practical procedure in this matter will call for serious consideration. With reference to such procedure, I beg to offer, in closing, the following suggestions:

On its academic side the standards-problem must be wrought out in this country chiefly by concerted action of the institutions concerned. It is of the utmost consequence that these institutions should find ways of working together, and avoid the danger of working at cross-purposes. The National Government has to do with the matter directly as an international question. Whatever diplomatic representations may be made in the matter from time to time must, of course, pass through the Department of State, and in these matters that Department acts ordinarily in consultation with the Department of the Interior. The Bureau of Education accordingly, for the Department of the Interior, forms the connection between the Government and the academic bodies which are concerned with the formulation of our American standards. It seems desirable that a consultative council for higher and professional education should be attached to the Bureau of Education, with a view to the effective handling of this and related questions, and that competent specialists should be employed on the staff of that office to deal with such questions. Direct conference between the educational bodies and educational leaders of this country and those of foreign countries, touching agreement concerning educational requirements and credentials, becomes increasingly desirable. Within the next few years it is to be hoped that such conferences may be frequently held. It should be a part of the program of American education to further the holding of such international conferences, and to bear our fair part in the proceedings of such conferences.

ELMER ELLSWORTH BROWN.

THE GEOGRAPHICAL DISTRIBUTION OF THE STUDENT BODY AT A NUMBER OF UNIVERSITIES AND COLLEGES

THE accompanying table explains the geographical distribution of the student body of twenty-one American universities, five New England colleges for men, five colleges for women, two technological schools and one Pennsylvania college and engineering school for men, for the academic year 1908–9, the summer session students being in every case omitted. *Indiana, Iowa, Johns Hopkins, Kansas, Nebraska, Northwestern* and *Stanford* have been added to the list, and the institutions have been separated into groups as they were last year.

Comparing the attendance by divisions of the six eastern universities (*Columbia, Cornell, Harvard, Pennsylvania, Princeton, Yale*) with the corresponding figures for the same universities in a similar table

A—UNITED STATES

1908–1909.	California.	Columbia.	Cornell.	Harvard.	Illinois.	Indiana.	Iowa.	Johns Hopkins.	Kansas.	Michigan.	Minnesota.	Missouri.	Nebraska.	North-western.	Ohio State.	Pennsyl-vania.	Princeton.
North Atlantic Div.	*14*	*3807*	*3856*	*3810*	*66*	*11*	*10*	*186*	*5*	*690*	*6*	*48*	*5*	*71*	*72*	*3561*	*925*
Connecticut		66	48	58	1	1		18		12		4		5	2	45	12
Maine	1	26	10	93			1	5		9				1	1	20	1
Massachusetts	3	89	109	2820	18	2		14		25	1	7	1	4	4	67	25
New Hampshire		18	8	79	3			3		5		1		1	2	10	3
New Jersey	1	458	201	60	2		1	8	1	10				4	3	380	264
New York	6	2990	2099	459	34	4	3	40	3	391	4	25	1	41	31	295	325
Pennsylvania	3	125	360	172	12	4		46	1	148	1	5	3	15	27	2900	285
Rhode Island		11	6	71	1			1		6						9	3
Vermont		9	14	28	1			3		14		1			2	5	2
South Atlantic Div.	*6*	*164*	*239*	*129*	*20*	*5*	*5*	*401*	*3*	*81*		*11*	*1*	*14*	*30*	*190*	*135*
		9	15	5				2								61	20
	2	12	47	32	4	1		7	1	36		1		1	3	23	22
		7	1	2	2	2		2	1	5		2				9	5
		27	14	18	3			15		7		2	1	1	3	18	1
	1	22	89	26	4		1	369		9				1	3	44	49
		23	18	14	2			13		2				4		16	7
	1	17	7	12	1		1	17		5		1			1	7	7
	2	25	29	11	4		3	30	1	6		2		4	6	19	10
		10	9	9		2		6		11		3		3	16	8	4
	11	*90*	*83*	*91*	*58*	*9*	*7*	*54*	*47*	*90*	*5*	*73*	*12*	*54*	*55*	*56*	*82*
Alabama		17	8	12	4		1	12		11		2		4		15	6
Arkansas		7	10	3	6			4	1	3		18	2	3	4	5	3
Kentucky	1	14	11	24	16	6	2	3	2	23	1	5	1	4	7	8	14
Louisiana	1	7	10	8	4			4		2			1	4	1	4	2
Mississippi		4	10	5	6		1	3		2		3		4	1	3	4
Oklahoma	2	7	4	5	10				41	18	2	26	5	13	1		
Tennessee	1	9	14	21	4	3	1	3		9		9	1	10	2	9	16
Texas	6	25	21	15	6		2	20	3	12	2	9	2	10	6	12	7
North Central Div.	*49*	*598*	*581*	*508*	*4012*	*1773*	*2158*	*76*	*2126*	*3650*	*4499*	*2168*	*3511*	*3078*	*2356*	*186*	*165*
Illinois	3	57	136	90	3448	28	30	14	3	258	14	67	7	1945	7	20	40
Indiana	6	65	39	44	132	1707	4	9	1	166	9	14		154	17	29	18
Iowa	7	24	24	47	68	2	2017	5	5	77	42	25	64	267	6	21	8
Kansas	2	23	14	19	26	1	6	6	1994	36	1	44	24	73	4	6	1
Michigan	3	85	40	32	41	2	3	1	1	2827	2	5	2	83	14	10	10
Minnesota	3	35	18	33	29	2	14	2		35	4228	2	1	90	3	14	13
Missouri	4	33	34	57	60	2	14	10	114	57		1961	9	68		14	17
Nebraska	2	16	8	12	27		10	3	4	25		5	3177	51	1	2	5
North Dakota	1	9	6	10	16		6			10	78		4	26	1	2	2
Ohio	1	86	168	135	49	28	1	19	3	381	3	13	2	77	7297	55	41
South Dakota		1	6	9	27		26	1	1	31	57	1	19	66			1
Wisconsin	7	24	29	24	74		3	6		47	70	4	2	175	6	13	6
Western Division	*3373*	*124*	*95*	*144*	*67*	*2*	*20*	*29*	*20*	*500*	*21*	*57*	*36*	*149*	*10*	*52*	*37*
Arizona	6	2	1	1	3					3	1	5		4			
California	3178	41	23	67	12			14	1	82	5	9	1	28	3	12	5
Colorado	6	15	16	26	15		7		12	48	1	15	10	16	3	8	11
Idaho	7	1	1	1	7	1	4			11	8	4	3	7		4	1
Montana	4	14	14	7	5		3	1		36		8	2	24	1		6
Nevada	9	1		1						1		1			1	1	
New Mexico	4	2		1	2	1		1	3	4		5		4	2		1
Oregon	33	17	12	12	2		2	3	1	18		1	1	7		2	3
Utah	2	3	15	8	7		2		3	10		6		22		13	4
Washington	23	22	11	16	14		2	9		28	6	3	4	29	1	12	5
Wyoming	1	1	2	4				1		9		2	15	6			1
Insular and Non-contiguous Ter.	*41*	*13*	*34*	*14*	*15*		*4*	*1*		*10*		*3*	*7*	*8*	*8*	*15*	
Alaska	3		1	1										1			
Canal Zone																2	
Hawaiian Islands	14	3	5	3						1		1					
Philippine Islands	4	6	12	1	13		4	1		3		2	7	6	5	1	
Porto Rico		4	16	4	3					6				1	2	12	
Total	3874	4564	3832	4220	4288	1799	2184	607	2301	4651	4551	2361	3373	3872	2501	4060	1301

1908–1909.	Stanford.	Virginia.	Wisconsin.	Yale.	Amherst.	Bowdoin.	Dartmouth.	Lehigh.	Mass. Inst. of Tech.	Purdue.	Wesleyan.	Williams.	Bryn Mawr.	Mt. Holyoke.	Smith.	Vassar.	Wellesley.
North Atlantic Div.	*40*	*36*	*58*	*2449*	*419*	*335*	*1067*	*559*	*1116*	*95*	*395*	*376*	*356*	*668*	*1189*	*678*	*931*
Connecticut	1	4	3	1180	24	2	29	6	31	1	96	19	6	101	107	52	47
Maine	2		3	16	4	254	42	1	22		14	10	1	29	47	5	40
Massachusetts	2	2	3	207	151	49	529	14	680	2	37	95	17	280	380	96	386
New Hampshire		6		17	3	14	232		24		2	1	8	26	33	11	35
New Jersey	3		6	125	30		17	66	14	18	42	42	15	41	114	68	92
New York	23	13	28	840	169	11	111	54	90	35	71	187	58	138	319	289	168
Pennsylvania	6	11	13	211	23		15	416	53	38	20	12	152	29	85	97	128
Rhode Island	1		2	30	6	4	10		28			3	4	12	19	3	23
Vermont	2		1	23	10	1	82		6	1	4	7		15	25	5	13
South Atlantic Div.	*9*	*550*	*19*	*117*	*14*	*3*	*13*	*76*	*81*	*8*	*11*	*6*	*41*	*9*	*39*	*17*	*25*
		1		14			1	3		1			1	2	3	3	1
	6	6	8	21	6	2	6	13	10	4	5	2	6	2	7	3	9
		19		11	2		1		6	1			1		2		1
		18	2	19					3	1	1	1	1		3	3	5
	2	22	2	14	5		3	46	17	1	2	1	23	1	8	2	2
	1	18		9				5	1			1	3	2	3	1	4
		11	4	4											1		
		442		12				7	11			1	6	2	1	4	2
		17	3	18	1		1	2	3		3				1	1	1
	14	*140*	*24*	*88*	*5*	*1*	*7*	*9*	*39*	*74*	*4*		*17*	*1*	*18*	*37*	*36*
Alabama		29	1	7	1	1		1	3	1			1		2	3	1
Arkansas	1	10	2	3			1		1	6			3		3	3	2
Kentucky	6	39	5	22	1		4	1	4	44	1		2	1	4	6	23
Louisiana		5	1	14					3		1		2				
Mississippi		15	2	4				2	3	3			2			1	1
Oklahoma	3	1	2	2					1	2			1			1	1
Tennessee	2	22	2	18	8			2	3	7	3		2		4	10	4
Texas	2	19	5	18			2	3	16	11			4		5	6	4
North Central Div.	*105*	*35*	*3659*	*565*	*64*	*4*	*127*	*15*	*121*	*1716*	*8*	*90*	*80*	*60*	*338*	*243*	*237*
Illinois	22	3	268	137	19	1	61	3	23	54	1	37	36	13	119	51	55
Indiana	16	3	39	25	1		5	1	9	1479	2	4	6	3	17	17	11
Iowa	22		104	23	2		3		14	14		4	4	8	19	15	23
Kansas	5	2	11	22			2		4	3			1	2	12	5	10
Michigan	1	4	27	35	4	1	8		7	30	1	2	3	10	23	32	23
Minnesota	6	2	36	46	2		10	2	6	7		16	4	3	28	17	21
Missouri	10	13	14	58	7		2	1	6	11		3	3		21	16	15
Nebraska	5	1	12	15	7	1	2		2	7		1	5	1	3	4	15
North Dakota	1		18	6			2	1	3					1	3	5	1
Ohio	10	3	25	165	20		25	6	30	108	3	16	12	14	58	54	46
South Dakota	3	1	40	5		1			3	7				1	1	1	5
Wisconsin	6	1	3099	18	2		2	1	12	6	1	7	4	6	19	26	18
Western Division	*1458*	*18*	*56*	*190*	*18*	*4*	*18*	*5*	*53*	*16*		*10*	*12*	*3*	*58*	*55*	*48*
Arizona	9	1		2											1	2	
California	1315	5	7	39	1	1	4		30	4		1	5	2	11	11	11
Colorado	18	4	10	30	1	2	10	1	5	7		5	2		14	11	13
Idaho	5		6	1			1		1						1		1
Montana	3	1	14	6	3			1	2	1			1	1	3	2	3
Nevada	12								1	1			1				2
New Mexico	2		2	2	1			1	1							1	
Oregon	28	1	3	12	7				4			2	2		5		2
Utah	14	1	2	7	2			2	6	1					4	1	3
Washington	42	1	9	30	3	1	3		13	4		2			12	5	7
Wyoming	2	1	3	1					1				1		1	2	1
Insular and Non-contiguous Ter.	*19*	*2*	*11*	*14*				*1*	*9*	*4*			*1*		*1*		*4*
Alaska			1	1													1
Canal Zone									1								
Hawaiian Islands	12		1	5					1				1				2
Philippine Islands			3	6					1	4					1		
Porto Rico		3	1	2				1	6								1
Total	1641	779	3357	3359	530	346	1231	665	1599	1015	316	459	407	741	1362	1010	1275

B—FOREIGN COUNTRIES

1908–1909.	California.	Columbia.	Cornell.	Harvard.	Illinois.	Indiana.	Iowa.	Johns Hopkins.	Kansas.	Michigan.	Minnesota.	Missouri.	Nebraska.	North-western.	Ohio State.	Pennsyl-vania.	Princeton.
North America	*5*	*59*	*47*	*45*	*12*	*1*	*4*	*12*	*2*	*33*	*5*	*10*		*30*	*11*	*64*	*6*
Canada	3	31	10	35	5	1	2	12	1	25	5	3		24	1	17	4
Central America		5	7		1									2		16	
Cuba		14	19	5											5	15	1
Mexico	2	6	10	2	6		2		1	6		7		2	4	8	
Newfoundland																2	
West Indies		3	1	3						2				2	1	6	1
South America	*6*	*11*	*33*	*5*	*7*			*2*		*6*		*6*		*2*	*10*	*38*	*1*
Argentine Rep.	4	2	12	2	5							1		2	6	7	
Bolivia																1	
Brazil			5	1	1			2		1						15	1
British Guiana										1							
Chili	1	2										2				1	
Colombia		3		1						4						5	
Ecuador	1	3	5													5	
Paraguay			5													2	
Peru		1	5	1	1							3			2	2	
Uruguay			1														
Europe	*13*	*55*	*90*	*47*	*14*	*1*		*4*	*4*	*12*	*4*	*10*	*2*	*16*	*3*	*56*	*2*
Austria-Hungary		8			1									1		2	
Belgium			1														
Bulgaria			1	2					1			2					
Denmark	2				1											1	
France		4	2	6				2								6	
Germany	4	8	1	12	1			1		7			2	3		15	
Gt. Britain and Ir'd.	3	13	3	15	1					1		2		3		7	2
Greece		1	1		1									2			
Holland	1	1	2	1					1	1						7	
Italy		1		3	1									2		3	
Norway	1		1		2	1					1			2			
Portugal																	
Rumania				1	1			1								2	
Russia	1	11	2	6	2				2	3	2	5			3	9	
		2			1												
		2	2		1									3		1	
		4	3	1	1					1	1	1				1	
	1	3	2													1	
	46	*42*	*60*	*43*	*29*	*7*	*11*		*3*	*16*	*6*	*10*	*5*	*12*	*16*	*31*	*5*
	17	12	33	35	9	3	1			6		5		1	2	22	
	1			1										1			1
	9	3	6	6	5		1			2		1	1	3	3		
Japan	18	23	10	8	11	3	9			5	6	4	3	1	2	8	1
Persia		1											1				
Siam	1			1													
Straits Settlements															1		
Turkey		3	1	2	4	1			2	3				6	3	1	1
Africa	*1*		*2*	*4*						*1*	*1*			*1*		*3*	*1*
Egypt				2										1		2	1
Madagascar											1						
South Africa	1		2	2						1							
Australasia	*5*	*1*	*5*	*3*						*1*				*10*		*35*	
Australia	3	1	5	1										9		20	
Caroline Islands																	
New Zealand	2			2						1				1		15	
Total (For. countries)	76	166	157	147	62	9	15	18	[illegible]	69	16	36	7	71	40	225	13
Total (United States)	3374	4584	3822	4220	4238	1798	2184	697	2201	4651	4531	2251	3372	3372	2501	4080	1301
Grand total	*3450*	*4750*	*3979*	*4367*	*4300*	*1807*	*2199*	*715*	*2210*	*4720*	*4547*	*2287*	*3379*	*3443*	*2541*	*4305*	*1314*

1908–1909.	Stanford.	Virginia.	Wisconsin.	Yale.	Amherst.	Bowdoin.	Dartmouth.	Lehigh.	Mass. Inst. of Tech.	Purdue.	Wesleyan.	Williams.	Bryn Mawr.	Mt. Holyoke.	Smith.	Vassar.	Wellesley.
North America	*6*		*17*	*24*			*1*	*12*	*49*	*10*	*2*	*1*	*3*	*1*	*2*	*3*	*3*
Canada	4		8	21				1	15	2	2		3		1	3	3
Central America			1					2	5	1							
Cuba			1	1				4	2	3							
Mexico	1		6	2			1	4	6	2		1		1	1		
Newfoundland																	
West Indies	1		1					1	1	2							
South America		*2*	*2*	*2*	*1*			*5*	*13*	*2*	*1*						
Argentine Rep.			1	1	1			2	2	1	1						
Bolivia																	
Brazil									3								
British Guiana				1													
Chili									1								
Colombia										1							
Ecuador		1						3	2								
Paraguay									1								
Peru		1	1						2								
Uruguay									1								
Europe	*3*		*8*	*18*	*1*	*1*	*1*		*8*	*1*	*1*		*7*	*3*		*1*	
Austria-Hungary				1													
Belgium																	
Bulgaria																	
Denmark																	
France				2	1		1						1			1	
Germany				2													
Gt. Britain and Ir'd.	1		5	4		1			4				6				
Greece										1							
Holland	1																
Italy				1					1		1						
Norway				1													
Portugal																	
Rumania																	
Russia			2	1					2								
			1	2													
	1																
				4					1					3			
	11	*2*	*19*	*42*	*6*	*1*		*5*	*18*	*6*		*4*	*3*	*3*	*1*		*4*
	2	2	10	21				7	10	3							2
	3		1	2	3	1		1	2					2			
Japan	6		6	15	3				4	3		2	2	1	1		1
Persia												1					1
Siam																	
Straits Settlements																	
Turkey				4					2			1	1				
Africa									*5*								
Egypt									2								
Madagascar																	
South Africa									3								
Australasia	*4*																
Australia	4																
Caroline Islands																	
New Zealand																	
Total (For. countries)	24	4	46	86	8	2	2	26	72	19	4	5	13	7	3	4	7
Total (United States)	1641	779	3857	3353	520	346	1231	665	1389	1915	318	482	407	741	1562	1010	1275
Grand total	*1665*	*783*	*3903*	*3439*	*528*	*348*	*1233*	*691*	*1461*	*1934*	*322*	*487*	*420*	*748*	*1565*	*1014*	*1282*

published in Science,[1] we note that there has been a gain for these universities, taken as a whole, in every division except one, namely, the South Central, which in 1908 exhibited an increase of 36 students. The largest increase by far was naturally recorded in the North Atlantic division, which was followed by the South Atlantic with an increase of 67 students, the North Central with a gain of 52, the Western with one of 39, and the insular and non-contiguous territories with one of 21. Foreign countries show an increase of only 11 over last year, while the South Central division has lost 44 students. The total increase in divisions outside of the North Atlantic was only 135 as against 381 last year, 189 in 1907 and 91 in 1906. So far as the gain in foreign patronage is concerned, this year's increase of 11 compares rather unfavorably with that of 92 in 1908, 64 in 1907 and 87 in 1906. Calculated on a percentage basis, the total gain of the six universities in the North Atlantic division during the past year amounted to 5.17 per cent., as against a gain of 2.89 per cent. outside of the division mentioned. This is the first time in several years that the percentage of increase has been larger in the North Atlantic division than outside of it, the total gain in the North Atlantic division in 1908 having been 2.30 per cent., as against an increase of 8.16 per cent. outside of the division mentioned, and in 1907 3.51 per cent. as against 5.73 per cent. In the South Atlantic division all of these institutions with the exception of *Harvard* show gains; in the insular and non-contiguous territories all with the exception of *Princeton* have experienced an increase; in the western division all show a small increase; in the North Central division the gains of *Columbia* and *Cornell* outweigh the losses of the other four, while in foreign countries the gains of *Cornell, Harvard* and *Pennsylvania* more than compensate for the losses of the three remaining institutions; *Princeton* alone shows a gain in the South Central division.

[1] N. S., Vol. XXVIII., No. 722, October 30, 1908, pp. 577–585.

Comparing these figures with those of 1905, we observe that the most substantial gains have been made by *Cornell* (140), *Columbia* (136) and *Yale* (59) in the North Central division; by *Cornell* (54), *Pennsylvania* (43), *Princeton* (38) and *Columbia* (34) in the South Atlantic division; by *Columbia* (18) in the South Central division, and by *Pennsylvania* (99), *Cornell* (57), *Harvard* (53) and *Columbia* (49) in foreign countries.

Taking the universities in the accompanying table by divisions, we find that *Harvard* has been passed in the North Atlantic division by both *Columbia* and *Pennsylvania, Cornell, Yale* and *Princeton* following in the order named. Of the western institutions, *Michigan* has by far the strongest hold on this division, attracting 620 students (as against 394 in 1905) to *Ohio's* 72, *Northwestern's* 71, *Illinois's* 66 and *Wisconsin's* 58. All of the western institutions included in both this year's and last year's tables show an increase in their clientele from this division with the exception of *Ohio* and *Wisconsin, Virginia* also showing a loss. *Harvard,* as usual, leads in all of the New England states, with the natural exception of Connecticut, where *Yale* has the largest following. *Columbia,* of course, has a considerable lead in New York and New Jersey, both *Columbia* and *Pennsylvania* drawing more students from that state than *Princeton* does, although it must be remembered that the professional schools give the two first-mentioned institutions an advantage over *Princeton*. *Columbia* is followed in New

York state by *Cornell, Yale, Harvard, Princeton, Pennsylvania,* although *Michigan* attracts more students from the Empire state (391, as against 195 in 1905) than *Princeton* or *Pennsylvania.* In New Jersey *Columbia* is followed by *Pennsylvania, Princeton, Cornell, Yale, Harvard. Pennsylvania* naturally leads in its own state, being followed by *Cornell, Princeton, Yale, Harvard, Columbia,* this order being identical with that of 1908.

Examining next the attendance of the group of men's colleges and technological schools, we note that the order for the entire division is *Massachusetts Institute of Technology, Dartmouth, Lehigh, Amherst, Williams, Bowdoin, Wesleyan—Purdue* naturally bringing up the rear. All of the institutions in this group show an increase in their representation from the North Atlantic states as compared with 1908. In New York state the order for the colleges remains unchanged, namely, *Williams, Amherst, Dartmouth, Massachusetts Institute of Technology, Wesleyan, Lehigh, Bowdoin.* Of the six New England institutions included in both the 1908 and 1909 tables, 29 per cent. of the students of *Amherst* as against 43 per cent. in 1906 have their permanent home in Massachusetts; *Bowdoin* draws 73 per cent. of its student body from Maine, as against 77 per cent. last year; 19 per cent. of *Dartmouth's* students, as against 24 per cent. in 1906 come from New Hampshire (25 per cent. as against 21 per cent. in 1906 from New Hampshire and Vermont); *Massachusetts Institute of Technology* drew 57 per cent. of its student body from Massachusetts, as against 55 per cent. last year, this being the sole instance of an increase in the percentage of patronage from the home state; 30 per cent. of *Wesleyan's* students, as against 35 per cent. last year, claim Connecticut as their permanent home, while *Williams* continues to enroll 20 per cent. of its student body from Massachusetts. *Williams* draws more than twice as many students from New York as from Massachusetts, *Amherst* also attracts more from the Empire state than from Massachusetts, and *Dartmouth* attracts more than twice as many from Massachusetts as from New Hampshire. 60 per cent. of *Lehigh's* student body hails from Pennsylvania, as against 58 per cent. in 1908 and 1907 and 60 per cent. in 1906, while 76 per cent. of *Purdue's* students claim Indiana as their permanent residence, this figure having remained stationary since 1908. It is thus seen that of the institutions included in this group *Dartmouth* attracts the largest percentage of students from outside of its own state, followed by *Williams, Amherst, Wesleyan, Massachusetts Institute of Technology, Lehigh, Purdue* and *Bowdoin.*

Of the eastern universities, *Pennsylvania* still possesses the largest percentage of enrolment from its own state, namely, 68 per cent., as against 67 per cent. in 1906; of *Columbia's* student body 63 per cent. come from New York state, as against 66 per cent. in 1906 and only 45 per cent. in the 1909 summer session; *Cornell's* percentage of New York students has dropped from 56 per cent. in 1906 to 53 per cent. in 1909; of *Harvard's* students 53 per cent., as against 54 per cent. in 1906, are residents of Massachusetts; of *Yale's* students 34 per cent., as against 33 per cent. in 1906, have their permanent residence in Connecticut, and of *Princeton's* students only 20 per cent., the same as in 1906, are residents of the state of New Jersey. In no individual case do these figures differ more than one per cent. as compared with last year, while compared with 1906 *Columbia* and *Cornell* have each increased their outside patronage by three per cent.,

Harvard has increased it by one per cent., *Princeton* has remained uniform, while the outside clientele of *Pennsylvania* and *Yale* has been lowered one per cent. since 1906. Of the other eastern universities included in the table *Virginia* draws 56 per cent. of its student body from its own state as against 53 per cent. in 1908, while *Johns Hopkins* attracts 43 per cent. of its students from Maryland.

Coming to the South Atlantic division and taking into consideration only the six eastern universities, we note that the order has not changed for the last three years, it being *Cornell, Pennsylvania, Columbia, Harvard, Princeton, Yale,* although *Johns Hopkins* and *Virginia* naturally have a larger following in this section than any of the northern institutions, and yet *Columbia* draws more students from North Carolina, South Carolina and Georgia than *Virginia* does. *Chicago* and *Michigan* are the only western institutions to make a fair showing in this group of states, while *Lehigh, Massachusetts Institute of Technology* and *Bryn Mawr* are the only colleges with a good representation from this division, their main strength lying in Maryland. So far as the individual states are concerned, *Pennsylvania* naturally leads in Delaware and *Johns Hopkins* in Maryland; *Cornell* leads in the District of Columbia, *Virginia* in Florida, its own state and West Virginia, and *Columbia* in Georgia and North Carolina, tying with *Johns Hopkins* in South Carolina. *Johns Hopkins* is second in Virginia, followed by *Cornell* and *Columbia.* Leaving the state of Virginia out of consideration and omitting *Johns Hopkins* on account of its large Maryland clientele, we note that all of the remaining six eastern universities with the exception of *Yale* have a larger following in the South Atlantic division than *Virginia.*

In the South Central division *Virginia* heads the list, followed by *Harvard* (91, as against 80 in 1905), *Columbia* (90–72) and *Michigan* (90–64), *Cornell* (88–76) and *Yale* (88–80), *Missouri, Illinois, Pennsylvania* (56–44), *Johns Hopkins, Northwestern* and *Princeton* (52–72). *Michigan* and *Columbia* have made the largest gains in this division, while *Princeton* shows a decrease since 1905. With the exception of *Massachusetts Institute of Technology,* the New England colleges have only a small following in this group of states. *Smith, Vassar* and *Wellesley* make a far better showing in both divisions than *Amherst, Bowdoin, Dartmouth, Wesleyan* or *Williams,* as they do in the North Central division. Indeed, the girls' colleges have a much less local attendance than the New England colleges for men, this being conclusively demonstrated by the following figures: From the three divisions just mentioned *Smith* draws altogether 380 students, *Wellesley* 298 and *Vassar* 297, as against 146 for *Dartmouth,* 96 for *Williams,* 83 for *Amherst,* only 23 for *Wesleyan* and only 7 for *Bowdoin. Bryn Mawr* attracts 138 of its students from the same section and *Massachusetts Institute of Technology* 211. *Smith* draws 119 students from the state of Illinois alone, more than *Amherst, Bowdoin* and *Wesleyan* combined do from the three divisions under discussion. *Barnard* college, on the other hand, has only 14 students from these three divisions. The largest representation from the individual states is found at the following universities: Alabama—*Virginia, Columbia, Pennsylvania;* Arkansas—*Missouri, Cornell* and *Virginia;* Kentucky—*Virginia, Michigan, Harvard;* Louisiana—*Yale, Cornell, Columbia;* Mississippi—*Virginia, Cornell, Illinois;* Oklahoma—*Kansas, Missouri, Northwestern;* Tennessee—*Virginia, Harvard, Yale;* and Texas—*Columbia, Cornell, Johns Hopkins.*

In the North Central division the order for the institutions located in that region is *Minnesota, Illinois, Wisconsin, Michigan, Nebraska, Northwestern, Ohio State, Missouri, Iowa, Kansas, Indiana, Purdue.* All of these, naturally, have a larger patronage in this division than any of the eastern universities, which come in the order *Yale, Cornell, Harvard, Columbia, Pennsylvania, Princeton, Johns Hopkins, Virginia—Cornell* and *Harvard* having exchanged places since last year. At the prominent universities of the middle west, the percentage of attendance from outside of the state in which the institution is located is, with the exception of *Chicago, Michigan* and *Northwestern,* much lower than it is in the case of the eastern institutions. The figures for percentage of enrolment from the home state are as follows: *Michigan* 54 per cent., *Northwestern* 56 per cent., *Wisconsin* 79 per cent., *Illinois* 80 per cent., *Missouri* 83 per cent., *Kansas* and *Ohio State* 90 per cent. each, *Iowa* 91 per cent., *Minnesota* 93 per cent., *Indiana* 94 per cent. and *Nebraska* 95 per cent. Of the two large universities on the Pacific coast *Stanford* is much less local in its student patronage than the *University of California,* the figures being 79 per cent. and 93 per cent., respectively. The largest gains (30 or more) in individual states since 1905 have been made in Illinois by *Columbia* and in Ohio by *Cornell* and *Yale. Columbia's* representation in this group of states has grown from 262 to 398 in four years, *Cornell's* from 381 to 521, *Yale's* from 506 to 595, *Pennsylvania's* from 139 to 186, while *Harvard's* has dropped from 526 to 502, and *Princeton's* from 209 to 162. Of the New England colleges for men, *Dartmouth* (127) has outgrown *Massachusetts Institute of Technology* (121) since last year in the size of its clientele from this division, *Williams* being third (90) and *Amherst* fourth (64), while the order for the girls' colleges is *Smith, Vassar, Wellesley, Bryn Mawr, Mt. Holyoke.* The first three of the girls' colleges mentioned have a much larger clientele from this division than either *Pennsylvania* or *Princeton.* The representation of *Amherst* in these states has grown from 43 to 64 in three years, that of *Dartmouth* from 91 to 127 and that of *Williams* from 86 to 90. Leaving the state institution or institutions out of consideration in each case, *Wisconsin* is seen to have the largest following in Illinois, having passed *Michigan* since last year, *Yale, Cornell, Smith* and *Harvard* following. *Michigan* retains its lead in Indiana, and is followed in that state by *Northwestern, Illinois, Columbia, Harvard, Cornell* and *Wisconsin.* In Iowa the order is *Northwestern, Wisconsin, Illinois, Michigan, Nebraska, Harvard;* in Kansas —*Northwestern, Missouri, Michigan, Illinois, Nebraska, Columbia;* in Michigan—*Northwestern, Illinois, Cornell, Columbia* and *Yale, Vassar;* in Minnesota—*Northwestern, Yale, Smith, Wisconsin, Columbia* and *Michigan;* in Missouri—*Kansas, Northwestern, Illinois, Yale, Harvard* and *Michigan;* in Nebraska—*Northwestern, Illinois, Michigan, Columbia, Yale* and *Wellesley;* in North Dakota—*Minnesota, Northwestern, Wisconsin, Illinois, Harvard* and *Michigan;* in Ohio—*Michigan, Cornell, Yale, Harvard, Purdue, Columbia;* in South Dakota—*Northwestern, Minnesota, Wisconsin, Michigan, Illinois, Iowa;* in Wisconsin—*Northwestern, Illinois, Minnesota, Michigan, Cornell, Vassar* —*Northwestern* being mentioned first in seven of the 12 states included in this division.

In the western division (leaving *California* and *Stanford* out of consideration) *Michigan* is still in the lead, with *North-*

western, *Harvard*, *Columbia* and *Yale*, each of which attracts over one hundred students from this section, following; then come *Cornell*, *Illinois*, *Missouri*, *Wisconsin*, *Massachusetts Institute of Technology*, *Pennsylvania* and *Smith*, the remaining institutions all drawing less than fifty students from this division. *Michigan's* representation has grown from 134 to 200 since 1905; *Harvard's* from 126 to 144; *Columbia's* from 111 to 124; *Yale's* from 78 to 115; *Cornell's* from 76 to 95; *Illinois's* from 41 to 67; *Pennsylvania's* from 22 to 52; while *Princeton's* has dropped from 41 to 37. *Michigan* leads in Arizona, Colorado, Idaho, Montana and Oregon; *Harvard* in California, *Missouri* in New Mexico, *Northwestern* in Utah and Washington and *Nebraska* in Wyoming. *Columbia* is second in California and Oregon, and *Michigan* in Washington.

Taking only the six eastern institutions mentioned at the beginning of the article into consideration and counting ties in fractions, we find that *Columbia* leads in $13\frac{5}{6}$ states, *Harvard* in $13\frac{1}{3}$, *Cornell* in $9\frac{1}{2}$, *Yale*, in 9, *Pennsylvania* in $3\frac{1}{3}$ and *Princeton* in none, as follows: *Columbia*—New Jersey, New York, Georgia, North Carolina, South Carolina, Alabama, Texas, Indiana, Kansas, Nebraska, Arizona ($\frac{1}{2}$), Montana ($\frac{1}{2}$), Nevada ($\frac{1}{3}$), New Mexico ($\frac{1}{2}$), Oregon, Washington; *Harvard* in Maine, Massachusetts, New Hampshire, Rhode Island, Vermont, Kentucky, Oklahoma, Tennessee, Iowa, North Dakota, South Dakota, California, Nevada ($\frac{1}{3}$), Wyoming; *Cornell* in the District of Columbia, Maryland, Virginia, Arkansas, Mississippi, Michigan, Ohio, Wisconsin, Montana ($\frac{1}{2}$), Utah; *Yale* in Connecticut, Florida, West Virginia, Louisiana, Illinois, Minnesota, Missouri, Arizona ($\frac{1}{2}$), Colorado, New Mexico ($\frac{1}{2}$); *Pennsylvania* in Pennsylvania, Delaware, Idaho, Nevada ($\frac{1}{3}$).

Cornell maintains its lead in the number of students from insular and non-contiguous territories, being followed by *Illinois* and *Pennsylvania*. *California* leads in Alaska and Hawaii, *Illinois* in the Philippines, *Cornell* in Porto Rico and *Pennsylvania* in the Canal Zone.

The number of foreign students at American institutions of learning is rapidly on the increase, and it is safe to say that the day is not very far distant when there will be more German students at American universities than American students at German universities. There were enrolled in 1909, 794 foreigners at the six eastern universities, as against 540 in 1905. Adding the foreign clientele of the other institutions in the table, we find that 34 American institutions attracted no less than 1,467 foreigners during the academic year 1908–9, this figure being, as all the other comparisons have been, exclusive of the summer session attendance. *Columbia* attracted no less than 42 foreigners to its current summer session, and no doubt several other universities can make a similarly good showing for the summer term. Taking the representation of foreigners at all of the institutions included in the table, it is found that the largest delegations are sent by the following countries: Canada 242, China 193, Japan 158, Mexico 81, Great Britain and Ireland 71, Cuba 70, India 60, Germany 56, Argentine Republic 52, Turkey 51 and Russia 50; China having passed Japan since last year, England having passed Cuba and India and Germany the Argentine Republic. 460 of the 1,467 foreigners hail from North America, 458 from Asia, 313 from Europe, only 154 from South America, 64 from Australasia and 18 from Africa.

Owing to the large delegation of foreigners in its dental school, *Pennsylvania* with 225 students from foreign countries continues to head the list, being followed by

Columbia 166, *Cornell* 157, *Harvard* 147, *Yale* 86, *Massachusetts Institute of Technology* 72, *Northwestern* 71 and *Michigan* 69. *Lehigh* with its 25 foreigners and *Purdue* with 19, make a far better showing than any of the New England colleges, while *Bryn Mawr, Mt. Holyoke, Smith, Vassar* and *Wellesley* have only 31 foreign students altogether, as against 21 at *Amherst, Bowdoin, Dartmouth, Wesleyan* and *Williams*.

Examining the foreign delegations of the different institutions by continents, we note that the order in North America is *Pennsylvania, Columbia, Cornell;* in South America—*Pennsylvania, Cornell, Massachusetts Institute of Technology;* in Europe—*Pennsylvania, Columbia, Harvard;* in Asia—*Cornell, California, Harvard;* and in Australasia—*Pennsylvania, Northwestern.* Of the countries that send at least ten students to any one institution *Harvard* leads in Canada and England; *Pennsylvania* in Central America, Brazil, Germany, Australia and New Zealand; *Cornell* in Cuba, Mexico, Argentine Republic and China; *Columbia* in Russia and Japan. As for individual countries the order for Canada is *Harvard, Columbia, Michigan, Northwestern, Yale;* for Cuba—*Cornell, Pennsylvania, Columbia;* for Mexico—*Cornell, Pennsylvania, Missouri;* for Germany—*Pennsylvania, Harvard, Columbia;* for England—*Harvard, Columbia, Pennsylvania;* for Russia—*Columbia, Pennsylvania, Harvard;* for China—*Cornell, Harvard, Pennsylvania, Yale;* for India—*California, Ohio State;* for Japan—*Columbia, California, Yale;* for Australia—*Pennsylvania, Northwestern.*

Rudolf Tombo, Jr.
Columbia University

THE UNIFICATION OF THE METHODS OF ANALYSIS OF FATS AND OILS

The International Commission for the Unification of the Methods of Analysis of Petroleum Products having been able to accomplish so much it was thought that a commission along similar lines to consider the analysis of fats and oils would be of equal value and the need for some work along this line is evident when we consider to what an extent oils and fats are bought and sold on chemical analysis.

In order to bring this about there have been organized in various scientific societies committees for this purpose. At the present time committees, or sections as they are called, have been formed in Germany, Italy, France, Sweden, Holland, Hungary, Switzerland and England. These committees or sections are for the purpose of making a study of the conditions existing in their own country preliminary to the organization of an International Commission.

The committee or section in this country is made up of three committees, one from the American Chemical Society, one from the American Society for Testing Materials and one from the Association of Official Agricultural Chemists, which united in forming what is known as the Joint Committee on the Unification of the Methods of Analysis of Fats and Oils.

The work of this section, or committee, is first to study the condition in this country preliminary to taking part in an international conference and this work the committee considers of the first importance. The committee has secured the active cooperation of the U. S. Bureau of Standards which will enable it to carry on its work under the most advantageous conditions as regards standardizing of necessary apparatus and chemicals and the preparation of tables and samples.

So far the work under way is, first, consideration of tables and methods of expression of specific gravity and consideration of standard temperature conditions.

Second, a consideration of the meaning of cold or cloud tests in oils and the collection of data as to methods used and their interpretation.

Third, a consideration of the proper method of expressing acidity in oils and fats.

Fourth, a consideration of the proper method of standardizing refractometers.

The committee is now engaged in the collection of information as to the practise in use by the chemists connected with the fat and oil industry of this country by means of letters sent to as large a number of chemists who would be interested in this work as possible. As soon as this information is collected it will be considered and if necessary cooperative work undertaken to decide on the most satisfactory method or mode of expression, and finally when this is done the committee will be in a position to make its recommendation. In order to prevent needless duplication of work in the various societies in this country, the committee is collecting data as to all the work being undertaken along this line and will try to assist in whatever way it can this work of bringing some order out of the present conditions in the analysis of fats and oils which are exceedingly unsatisfactory.

The committee expects, from time to time, to publish the results of its investigations and if thought advisable make recommendations. Any person desiring information regarding the work or information along these lines should address the secretary of the committee, C. N. Forrest, Maurer, N. J.

SCIENTIFIC NOTES AND NEWS

AT the close of the second week of the celebration of the twentieth anniversary of Clark University, further honorary degrees were conferred as follows: doctorate of laws on Marston T. Bogert, professor of organic chemistry in Columbia University; Arthur Michael, the first professor of chemistry in Clark University, professor of chemistry in Tufts College; A. A. Noyes, professor of chemistry in the Massachusetts Institute of Technology; W. A. Noyes, professor of chemistry in the University of Illinois; the degree of doctor of chemistry on Theodore W. Richards, professor of chemistry in Harvard University; of doctor of science on André Debierne, of the University of Paris, and Julius Stieglitz, professor of chemistry in the University of Chicago.

THE medical department of Stanford University, formed by amalgamation with Cooper Medical College, was formally opened on September 8. Dr. H. A. Christian, dean of the Harvard Medical School, made the principal address, the subject of which was "The Career in Medicine and Present-day Preparation for it." This address will be published in SCIENCE.

PROFESSOR J. ARTHUR THOMPSON, of the University of Aberdeen, is giving in South Africa under the auspices of the South African Association for the Advancement of Science a series of lectures in celebration of the Darwin centenary.

MR. O. H. TITTMAN, chief of the U. S. Coast and Geodetic Survey, is the member for the United States of the permanent commission of the International Geodetic Association, the meeting of which was held in London beginning on September 21.

AT the recent meeting of the International Otological Congress at Budapest, Professor Clarence John Blake, of Harvard University, was elected president of the next congress, to be held in 1912, in Boston.

AN Illuminating Engineering Society has been founded in London, with Professor Sylvanus P. Thompson as the first president.

PROFESSOR RALPH S. TARR, Cornell University, will spend the current year in Europe on sabbatical leave.

PROFESSOR H. F. CLELAND, of Williams College, spent July and August in studying certain geological features of Wolff County, Ky., and of the Forest Reserve south of Flagstaff, Arizona. He also visited the Grand Canyon of Arizona, the Yosemite and Canadian Rockies.

SECRETARY CHARLES D. WALCOTT, of the Smithsonian Institution, has returned to Washington after a seven-weeks' trip in the higher Canadian Rockies to the north and south of the main line of the Canadian Pacific Railroad. In continuation there of his geological work in the main range of the Rocky Mountains Mr. Walcott found the base of the great Cambrian System in a fossil sea-beach that now forms a bed of white quartz pebble conglomerate some 300 feet in thickness. Below this, 4,000 feet of limestone of an older period were measured, and above it over 12,000

feet of Cambrian limestones, sandstones and shales, in which fossils were found at many horizons. Large collections of rocks and fossils have been sent to the United States National Museum.

The expedition from the Peabody Museum of Harvard University to South America, under the patronage of Louis J. de Milhau, has returned. The past three years have been spent in explorations on the headwaters of the Amazon River in the interior of Peru and Bolivia. The primary object of the expedition was the study of the native tribes of these little known regions. Incidentally, collections were made in natural history, meteorological observations were taken, and topographical work was done. A map of the entire region, based on traverses and astronomical observations, was made for the Peruvian government. The field work of the expedition was done under the direction of Dr. William Curtis Farabee, assisted by Dr. E. F. Horr, Mr. L. J. de Milhau and Mr. J. W. Hastings.

Mr. Delos Arnold, donor of the Arnold Geological Collection of the department of geology, Stanford University, died at his home in Pasadena, California, on August 31.

Mr. Thomas Southwell, of Norwich, known for his work on ornithology and on whales, died on September 5, at the age of seventy-nine years.

An International Congress of Radiology and Electricity will be held at Brussels in 1910. The congress is under the patronage of the Belgian government and the French Society of Physics.

The third International Congress of School Hygiene, to be held in Paris, has been postponed until the first week of August, 1910.

The ninth annual New England Intercollegiate Geological Excursion will be taken in the northern Berkshires, Saturday, October 9. A formal meeting will be held at the Wellington Hotel, Pittsfield, Mass., at eight o'clock Friday evening at which papers on the structural and glacial features and the anthropogeography of the region will be read and the outline of the excursion of the next day will be given. More detailed notices will be sent to all geologists and geographers who have attended former excursions and to others who will write to the secretary, Herdman F. Cleland, Williamstown, Mass.

The public museum of the Staten Island Association of Arts and Sciences, in Borough Hall, New Brighton, should be added to the list of institutions in which commemorative Hudson-Fulton exhibits have been installed. This exhibit, which was opened with appropriate ceremonies on September 4, the actual anniversary of Hudson's landing on Staten Island, is designed to illustrate the historical development of the island during the past three centuries. The original fauna and flora is shown, either by actual specimens or explanatory labels; the Indian occupation of the island is well illustrated by implements of agriculture, war and the chase, and by a model of a Manahatas Indian village. The colonial period is represented by various old prints, maps, a collection of antiques, etc. There is also a model of the water gate at the foot of Pearl Street during the Dutch period, and a model of the interior of a typical Dutch home. The costumes of various nationalities which have contributed to American citizenship are also shown. The museum is open from 1 to 5 P.M. daily except Monday; on Saturdays it is open from 10 A.M to 5 P.M.

A letter has been received at the Harvard College Observatory from Professor E. B. Frost, director of the Yerkes Observatory, stating that Halley's comet was observed visually by Professor S. W. Burnham with the 40-inch telescope, on Sept. $15^d\ 21^h\ 39^m$ G. M. T., in App. R. A. $6^h\ 18^m\ 51^s.1$ and App. Dec. $+17°\ 9'\ 44''$. The comet followed B. D. $+17°$ 1232 by $12^s.7$, North $4'\ 12''.1$. The comet was also photographed with the 2-foot reflector, on September 15 and 16, by Mr. Oliver J. Lee. A second letter from Professor Frost states that the comet was also observed visually by Professor E. E. Barnard, on Sept. $17^d\ 21^h\ 1^m\ 30^s$ G. M. T., in App. R. A. $6^h\ 19^m\ 0^s.90$ and App. Dec. $+17°\ 9'\ 0''.8$. The comet followed A. G. 2122 ($=+17°$ 1232) by $0^m\ 22^s.55$, North $3'$

28″.9. "Description: 15½ magn., 12″ diameter, with possibly a faint nucleus or indefinite fleck of light in it." The comet was also photographed by Mr. Lee at the same time.

LECTURES will be delivered in the Lecture Hall of the Museum Building of the New York Botanical Garden, Bronx Park, on Saturday afternoons, at four o'clock, as follows:

September 25—"Native Trees of the Hudson River Valley," by Dr. N. L. Britton.

October 2—"Some Floral and Scenic Features of Porto Rico," by Dr. M. A. Howe.

October 9—"The Flora of the Upper Delaware Valley," by Mr. George V. Nash.

October 16—"Collecting Fungi at Mountain Lake, Virginia," by Dr. W. A. Murrill.

October 23—"Autumnal Wild Flowers," by Dr. N. L. Britton.

October 30—"Some Plant Diseases: their Cause and Treatment," by Mr. Fred J. Seaver.

November 6—"The Reclamation of the Desert in San Bernardino Valley, California," by Dr. H. H. Rusby.

November 13—"The Hudson River Valley before the Advent of Man," by Dr. Arthur Hollick.

IT is stated in the *British Medical Journal* that the sanitary commissioner with the government of India has proposed the formation of a permanent organization to inquire systematically into the problems, both practical and scientific, connected with malaria in India. The governor-general in council has decided to convene a conference to examine the whole question, and to draw up a plan for the consideration of the government of India and the local governments. The conference will assemble at Simla on October 11, and is expected to last about a week. Each local government is nominating to the conference an administrative officer of experience, a medical officer and an Indian gentleman.

IN February last Surgeon C. P. Wertenbaker, of the Public Health and Marine-Hospital Service, in giving an illustrated lecture on tuberculosis before the Negro Farmers' Conference at Savannah, Georgia, suggested the organization of a State Anti-tuberculosis League for Negroes. The idea was well received and a league was organized. The proposed plan of organization contemplated a league in each state, with a branch in every colored church. This plan, which has been followed, is given in detail in the Public Health Reports of May 28, 1909. The movement was indorsed by the last conference of state and territorial boards of health. Up to August 6, leagues had been formed in the following states: Georgia, Louisiana, Mississippi, North Carolina and Virginia. "A Working Plan" for these leagues has been published in the Public Health Reports of September 3, 1909, giving in detail the method of organization of state leagues and of the local branch leagues. The "Proposed Plan of Organization" and the "Working Plan" have been reprinted, and limited editions are available for distribution to those interested in the work. Requests for copies should be addressed to the Surgeon-General, Public Health and Marine-Hospital Service, Washington, D. C.

THE Reale Accademia dei Lincei has, as we learn from *Nature*, made awards as follows: The royal prize for mathematics is divided equally between Professors Enriques and Levi-Civita, and that for social and economic sciences is similarly divided between Professor Rodolfo Benini and Dr. G. Mazzarella. From the Santoro foundation the academy has awarded a prize of 10,000 lire to Professor Quirino Majorana, for his researches on wireless telephony; in addition minor awards to Professor Gabbi, for researches on Malta fever, and to Dr. Canovetti, to enable him to continue his experiments on air resistance. From the same benefaction grants have also been made to Professors Vinassy de Regny and Gortani, for Alpine studies; Professor Gorini, for investigating diseases of cheese; Professor Silvestri, noxious insects; Professor Almagià, study of precipices; the Lombardy commission for seiches on Laghi di Garda and Maggiore; Dr. Abetti, solar physics, in Professor Hale's observatory. The Carpi prize for experimental physiology is divided between Drs. Baglioni and Lombroso. The late Professor Sella has bequeathed to the academy a prize of 1,000 lire, to be awarded annually to some assistant in an Italian physical laboratory.

THE *Electrical World* states that according to M. P. Bellile, a French naval surgeon on board the *Descartes*, which has been engaged in the campaign in Morocco, the members of the ship's company who were employed in wireless telegraph duty developed various affections in consequence of the action of the Hertzian waves. Most commonly the telegraphists complained of their eyes, a slight conjunctivitis similar to that occurring among those who work with arc lamps being found. Although this of itself was not generally serious, in one case where the attacks recurred again and again, keratitis was produced which resulted in a leukoma of the right cornea and consequent impairment of vision. In order to protect the eyes from the ultra-violet rays of electric emanation, it was recommended that yellow or orange glasses should be worn. Not only were the eyes of the operators affected, but two cases of eczema—one of the wrist and one of the eyelid, both very difficult to cure—were seen. One of the officials who had been employed for several years in wireless telegraphy suffered from a painful palpitation of the heart, which came on after working for any length of time at the instruments for sending messages. This man was quite free from any organic lesion of the heart. M. Bellile is disposed to think that a good many of the cases of nervousness and neurasthenia, which seem now to be getting rather common among naval men, may be due to the work which is being done in wireless telegraphy.

UNIVERSITY AND EDUCATIONAL NEWS

IT is proposed to form a University of Detroit by amalgamation of the law and medical colleges already existing in the city.

MRS. RUSSELL SAGE has given $50,000 to Syracuse University for a Teachers College.

THE installation of Dr. A. Lawrence Lowell as president of Harvard University will take place on the morning of October 6.

DR. EDMUND C. SANFORD, A.B. (California, '83), Ph.D. (Johns Hopkins, '88), professor of experimental psychology in Clark University, has been elected president of Clark College to succeed the late Carroll D. Wright. Dr. James F. Porter, of the department of psychology, has been appointed acting dean of the college in the place of Professor Rufus C. Bentley, who has resigned.

PROFESSOR HERBERT J. WEBBER, will act as director of the Agricultural College of Cornell University during the absence this year of the director, Professor L. H. Bailey.

MR. H. I. STOEK, for many years editor of *Mines and Minerals*, has been appointed professor of mining engineering at the University of Illinois. He has recently been serving as an expert of the United States Geological Survey in charge of investigations of waste in mining anthracite. During the past three years he has lectured on mining at Cornell University, Pennsylvania State College, Sheffield Scientific School and Brooklyn Polytechnic Institute.

MR. W. E. WICKENDEN, of the University of Wisconsin, has been appointed assistant professor of electrical engineering at the Massachusetts Institute of Technology, to assume the duties vacated by Professor George C. Shaad, who has gone to take charge of the department at the University of Kansas.

THE following changes have been made in the science departments at the University of Maine for the present year: Ralph H. McKee, Ph.D. (Chicago), professor of chemistry; Charles W. Easley, Ph.D. (Clark), associate professor of chemistry; Benjamin E. Kraybill, B.S. (Franklin & Marshall), instructor in chemistry; G. A. Scott, B.S. (Wisconsin), instructor in physics; E. C. Drew, B.S. (Vermont), tutor in physics; W. E. Wilbur, B.S. (Maine), S. D. Chambers, B.S. (Baldwin), and T. L. Hamlin, M.A. (Missouri), instructors in mathematics; G. E. Simmons, M.S. (Ohio State University), and M. E. Sherwin, M.S. (Missouri), assistant professors of agronomy; W. R. Palmer, B.S. (Oregon Agricultural College), instructor in horticulture; J. R. Dice, B.S. (Michigan Agricultural College), instructor in animal industry; Laura Comstock, assistant professor of domestic science; N. H. Mayo, B.S. (Maine), and W. E. Connor, B.S. (Maine), tutors in civil engi-

neering; E. C. Cheswell, instructor in engineering laboratories; P. L. Bean, B.S. (Maine), promoted to associate professor of civil engineering; A. L. Grover, B.S. (Maine), promoted to assistant professor of drawing.

Dr. Otto Grossner, of Vienna, has been elected professor of anatomy at the University of Prague.

DISCUSSION AND CORRESPONDENCE

THE HARVARD CLASSICS AND HARVARD

I. *The Harvard Classics*

Some one quotes to me a remark of William James's, "That no body of men can be counted on to tell the truth under fire." Perhaps "firing" is, after all, not a very effective method of searching for truth; and perhaps those who do the firing are more bent on making points than on getting to the root of the matter.

Two letters which I wrote during the summer to Harvard officials, on the "Harvard Classics" illustrate, aptly enough, the weakness of controversial methods as a means of securing assent to anything. In one of these public letters I asked Dr. Eliot, and in the other I asked Mr. Henry L. Higginson, trustee of Harvard, whether Harvard College had indeed granted the use of its name to the famous five-foot-shelf publication to which the public is now being invited to subscribe. No public answer was given to the letters; but the fact remains that the university did, by formal vote, lend its name to this book enterprise.

At this time I can realize, in re-reading these letters, that there was in them a good deal of desire to give pain, to see the worst, to nail the claws of the offenders to the ground, to state facts in such a way that the Harvard officials could not answer without making humiliating confessions and without, in effect, acknowledging that I was more virtuous than they.

At the bottom of the whole situation, however, and behind the conditions which produced the "Harvard Classics" there are certain facts about American culture to-day that ought to be considered dispassionately. It required a very peculiar juncture of influences between our educational world and our commercial world to produce "the Harvard Classics."

For the last thirty years Harvard has been struggling to keep the lead among American colleges; and Harvard has been content to take its definition of leadership—to adopt its ideal of leadership from the commercial world. We see in this the atmospheric pressure of industrial ways of thinking upon an educational institution. The men who stand for education and scholarship have the ideals of business men. They are, in truth, business men. The men who control Harvard to-day are very little else than business men, running a large department store which dispenses education to the million. Their endeavor is to make it the *largest* establishment of the kind in America.

Now, in devising new means of expansion, new cash registers, new stub systems and credit systems—systems for increasing their capital and the volume of their trade—these business men have unconsciously (and I think consciously also) adopted any method that would give results. A few years ago their attention was focused upon increasing their capital (new buildings and endowment): to-day it is focused upon increasing their trade (numbers of students). The whole body of graduates is being organized into a kind of "service" to employ Harvard men, to advertise Harvard, to make converts, to raise money, to assist in a general Harvard forward movement.

Henry Higginson and Charles W. Eliot and Dr. Walcott and Dr. Arthur Cabot, and the various organized agencies under them, feel that Harvard should be kept in the front; and they are willing to appeal to self-interest in the youth of the country in order to get that youth to come to Harvard. It is given out that Harvard means help for life; Harvard is for mutual assistance; Harvard means cheap clubs and many friends on graduation. The wonderful ability of the American business man for organization is now at work consolidating the Harvard

graduates into a corps, which, to the casual observer, seems to have much the same sort of enthusiasm about itself as a base-ball club.

I would cite in passing the circulars issued from time to time by Harvard committees upon such occasions as Dr. Eliot's seventieth birthday or the raising of the three million fund—occasions such as arise in the history of any institution, and against which nothing can be said. It is to the language of these appeals, through which Harvard calls upon her "loyal sons" to rally, to shout and to subscribe that I would call attention; for the language is the language of display advertising. Unless there were in the hearts of the men something less bombastic and more reverent than in this literature, it would be hardly worth while to build up the university. Yet these documents are issued by sincere men who are doing the best they know to spread education and righteousness.

The latest form which the business sagacity behind Harvard University has taken to secure cheap advertising for the institution is to lend out the grounds and the name of the college to the most experienced professionals of the epoch, and to allow these professionals to do the rest. The first example of this was the performance of Joan of Arc given by Charles Frohman in the Stadium last spring, in which Maud Adams personated the Maid of Orleans. This show had in it nothing that was artistically justifiable, except the costumes and the training of the supers, both of which were indeed remarkable. The rest of the performance was meaningless and somewhat discreditable to the culture of Harvard. The whole affair, however, was not an example of culture, but of business enterprise. As a result of it, every newspaper in the land contained a column about Harvard College. Note that the professionals were called in; for this is what connects the Joan of Arc with the "Harvard Classics."

I will not pretend that the combination in which *Collier's*, Dr. Eliot and Harvard find themselves embarked was a cold-blooded scheme to exploit the credit of the university and put cash into Dr. Eliot's and Mr. Collier's pockets. It was nothing of the sort. The situation was one into which all of the parties slid by operation of natural force; but the corporation and Dr. Eliot would never have got into it, had not the corporation and Dr. Eliot been long and deeply submerged in commercial measures.

It was an excellent idea of Dr. Eliot's to issue a list of books which he thought good, and have them printed in cheap form. Professor Norton in his last years spent much loving thought over his "Heart of Oak Series of Readers," and went down to his grave honored for this enterprise. But Professor Norton did not find it necessary to borrow the name of the university, nor to submit to the control of a publishing house. The present board of trustees, however, saw in Collier's offer to finance Eliot's project a chance to spread the influence of the college. I will not include President Lowell in these remarks, because I do not know exactly what position he has occupied; and in any case he should be let alone till he is more securely in power. It would be asking too much of him that he should veto a personal pet scheme of his predecessor's in the very moment of his own entry into office. The spreading of the influence of Harvard, then, is what the trustees had in mind—the making of a little money and the doing of a great deal of good is what Dr. Eliot had in mind: the making of a great deal of money and the doing of a little good is what *Collier's* had in mind. But here is the point: Once launched, *Collier's* is in control. The name of Harvard is an asset worth thousands of dollars. The size of the scheme may be measured by the money that *Collier's* is pouring into it. Eliot and Harvard have become mere trade-marks. We shall very likely live to see their names on collar-boxes—a picture of Eliot, a box of soap and a set of the "Harvard Classics."

It is hard to blame Dr. Eliot. He has chosen a list of books, and a little bad taste in the advertising will carry his name and his books where good taste will not carry them. The notes and glossaries of these books will, it is stated, be done by a most competent

hand; and, except that the work is being so hurried as to make scholarship a secondary consideration, these notes and glossaries should be excellent. We must remember, too, that Dr. Eliot is not only a sincere lover of popular education, but is sincerely ignorant of what constitutes higher education.

But what shall we say of the trustees, who apparently are in complete ignorance that they are holding the ægis of the university over the book trade? Does this seem to you to be a small matter, or a matter for laughter? For what purpose does a university exist except to be a guide to the people in true scholarship, to be a light and not a false beacon to the half-educated, to be a touchstone and a safe counselor to those who honor learning and who desire to be led toward her?

There never was a country in the whole history of the world, where the people stood so much in need of honest dealing from their intellectual leaders as they do in the United States to-day. These hordes of well-meaning people, uneducated and yet hungry for education, are apt to believe what any clever person tells them. They become the prey of educational mountebanks, of tawdry impostors, of innocent quacks. "Prophesy unto us smooth things" is their cry. Show us that culture is easy, tie it up in ribbons, let it be a "crimson effect" and bear a souvenir water-mark. Show us that a man may become an educated man by reading for fifteen minutes a day in some certain books, and give us all of them—on a shelf, every one—on the instalment plan.

Culture of this kind our people must have and will have, and it is right that they should have it. They require to be spoon-fed, and we need not have any fear that they will not get their food. But it makes a great difference, to the whole of America, who holds the spoon. Harvard College can not hold it without abandoning her true mission.

II. *Harvard*

Liberty of spirit and of speech is the great gift that education brings with it. A university is a censer of sacred fire at which young men may light their torches, and go out invigorated into the world. They remain throughout life, no matter how uninspired their lives may be, in some sort of touch with the influences of their university. They never lose their enthusiasm, at least, for the name of the place which once evoked it. Amid all the emptiness of college shouting there is the ring of a little golden bell of truth, a sentiment of reverence for intellect, a feeling of unity with the history of mankind. It is this thing, which all universities have in common, that makes them valuable; and not the divergencies upon which they pride themselves. They brag, they compete, they strut; and yet the thing they would bring into honor can only be diminished by competition, and extinguished by bombast.

The fomenting of a "Harvard sentiment" is an injury to Harvard intellect. This *esprit de corps* has been developed to such a pitch of tyranny in some of our colleges that the brains of the boys are often a little addled for life by it. I believe that Harvard has a more liberal tone than the other American colleges. This is due to her antiquity and to her proximity to Boston—for Boston feeds and nourishes Harvard, and educated people have more influence in Boston than elsewhere in America.

It is with a kind of joy that I attack Harvard College, knowing that Harvard supplies the light and the liberalism—hardly elsewhere to be found in America—by which I am permitted to proceed. I should grieve to have this freedom extinguished, as it would be if the alumni were forbidden to take a critical interest in the institution. Loyalty to truth is a fine thing; but loyalty to anything else is an attack upon truth.

It is supposed that Harvard's leadership has been due to her numerical superiority, and that this numerical superiority must therefore be maintained at all costs. It is probably true that Harvard is morally and intellectually in advance of the other American colleges; and it seems likely that she will lose her leadership through her attempts to retain it. She can not compete in size with the state univer-

sities; but she can, by attempting to do so, lose her distinctive position and become illiberal and stupid. Let Harvard abandon the ambition to be the biggest college—or the second or sixth biggest college—and be content to remain the biggest influence in the college life of America. On the day after she had turned her face in this direction, there would be an improvement in spirit in every university in the country. The senseless rivalry to secure students would be, in some degree, relaxed and a new standard of ambition would be introduced. The large sums of money which Harvard is now raising and wasting to her own undoing, could be turned to other uses; and the energy of those men who toil so ceaselessly at Harvard's propaganda could be discharged where it belongs—into the business world.

I do not see any signs of such a change of front on Harvard's part, and I utter this only as a hope, and in an Emersonian spirit. But I will give one piece of practical advice upon the subject, so practical, in fact, that it sounds almost like the advice of a business man.

If you wish to have a university, you must have scholars and scientific men on the governing boards. With the exception of President Lowell there is not a scholar among "The President and Fellows of Harvard College." They are all business men, lawyers or doctors. Now doctors are, for hospital purposes, scientists and scholars; and I will wager that the Massachusetts hospitals will bear comparison with any hospitals in the world from every point of view. But if you should exclude the doctors from the boards of hospital management, as you have excluded learned men from the management of Harvard University; and if you should hand over the Massachusetts hospitals to the management of business men, as Harvard University has been handed over to the management of business men, your hospitals would soon sink below the standards of Europe. Now, learning is not safe if left exclusively in the hands of business men, just as philanthropy would not be safe if left exclusively in their hands. Learning can be protected and transmitted only through the enthusiasm of those men to whom learning is a religion; that is to say, through scholars and the high priests of science.

John Jay Chapman

HISTORICAL GRAPHICS

To the Editor of Science: Referring to the short article on "Historical Graphics," by Dr. Barus (page 272), I might say that two years ago during the summer vacation I worked out a similar historical chart for botany, and used almost exactly the same methods that Dr. Barus has. I went back to several centuries before the Christian era and brought my chart down to 1900 as he did. The chart was made on a long strip of common opaque "curtaining" and I drew lines as he did for the dates. On account of covering so many centuries I allowed but ten inches for each century and did not put in, as he has done, the half centuries. My chart extended something like twenty feet and I followed exactly the plan suggested by Dr. Barus of indicating the life of each man by a horizontal line. In my chart, however, I drew these life symbols as rectangles about two inches high and stretching right and left the proper length. Inside of this rectangle the name of the botanist was printed in capital letters. This has the advantage of avoiding any possibility of mistaking the line belonging to any particular name. After I had worked out my plan on a smaller sheet of paper it was enlarged into the chart of which I speak, and has been hanging for two years across the end of my lecture room. I keep it permanently in place, as in this way students become gradually acquainted with the general distribution of names. I am sure that Dr. Barus's plan is an admirable one, and it certainly has served a very good purpose in my lecture room.

Charles E. Bessey

STATISTICS OF TELEGONY

To the Editor of Science: The letter of Mr. O. F. Cook in your issue of August 20 is so characteristic of the attitude of certain biologists to biometry that perhaps you will spare me space for a brief commentary on it. Mr. Cook writes:

Pearson's plan of proving or disproving telegony by a statistical study of the degrees of resemblance of children to fathers rests more on mathematical ideas than on biological indications, to judge from Thompson's account of it.

I should not like to be responsible for any biologist's account of my work, and it was perfectly open to Mr. Cook, as Thompson presumably cites the locus of my memoir (*Royal Society Proc.*, Vol. 60, p. 273, 1896), to have consulted it, for he writes from Washington. However, he has not chosen to do so, and prefers to suggest that I have not done the very obvious thing to do, namely, compare maternal and paternal resemblances in the case of elder and younger children. I do not know whether a man makes himself ridiculous in the biological field when he criticizes another for not doing exactly what he has done, but I do know what we think of him in the sphere of the exact sciences!

KARL PEARSON

SCIENTIFIC BOOKS

BAILEY'S CYCLOPEDIA OF AMERICAN AGRICULTURE

THE twenty-five hundred two-column quarto pages of Bailey's "Cyclopedia of American Agriculture," recently from the press, mark a milestone in American agricultural thought. It is a compact library of scientific and usable fact and philosophy of country life in America. Volume I. passes in review the important agricultural features of the United States, her tropical possessions, Canada and Mexico, as seen by many independent observers. It deals with the interior of the farm as conditioned by its environment of soil and climate; with its development by capital and equipment into a source of profit; and with its sanitation and adornment as a place of abode. Volume II. deals with farm and field crops, their botany, their uses, their improvement by breeding, the introduction of better plants, the methods of growing and marketing crops, together with the manufacture and sale of crop products. Volume III. treats of animals, the history of the formation of breeds, the facts, philosophies and practise in animal breeding and animal feeding; the development of live stock products, the methods of preparing for the markets and marketing them. Volume IV. considers the more general matters of rural affairs; of the relations of the farm as a business entity to the world about, our national agricultural resources, the growth of agricultural wealth, machinery, city markets and other forces which impel the increase of agricultural production. Facts are given about land tenures; concerning labor; social, church and economic organizations, both cooperative and under the legal machinery of the state. Education for country life is dwelt upon, as also governmental aid by means of research institutions, and through police control as of fertilizers, feed stuffs, animal diseases and plant diseases.

To this encyclopedia more than a thousand technical agriculturists, general scientists and economists contributed articles or revised the work of others; and the text is illuminated with more than twenty-five hundred illustrations. The primary arrangement of the subject matter under a logical topical classification instead of the ordinary alphabetic arrangement of cyclopedia makes the book more readable and less a mere reference book. These books, at five dollars per volume, will in a way compete with correspondence courses in agriculture. The person who will read intelligently these four books will have absorbed a large part of the best knowledge of American agriculture, and he will find that henceforth he will read agricultural periodicals and technical bulletins and books on agriculture and country life with more discernment—and the farm boy who will read through the more interesting and vital parts of these volumes will enter upon the work of the agricultural school and agricultural college with an advantageous viewpoint not possessed by most of his fellow students. Model farm homes which have a group of boys in their teens will no doubt be the chief markets for these four books. These volumes, together with the bulletins and reports from departments of agriculture and experiment stations, form a splendid basis upon which to start the agricultural side of the farm family library.

These volumes offer the broadest and best general single exposition of the output of our

agricultural research and educational institutions. They form a good key to the body of knowledge already accumulated. They are in part history. Their substance gives prophecy of the greater things which are to come.

In another decade or two science will have not only doubled our definite knowledge of things agricultural, but will have reduced this body of thought to pedagogic form and will have secured it a place beside the three R's in our rural schools. Had these volumes been written two or three years later the author would have placed the consolidated rural school—the farm school out in the open country or in the village—foremost as an educational agency in country life. And the publishers will find that these rapidly multiplying schools, so organized as to support school and circulating libraries in the rural communities, will be one of their largest markets for sets of these volumes.

This encyclopedia will prove of especial value in the library of all secondary schools and colleges, whether patronized by city- or country-bred youth. It will be a source of information not only in regard to subject matter for use in class work—but as the basis of essays, debates and other literary efforts. The presence of this body of knowledge will make it possible for teachers to assign more written work on concrete subjects, that the pupils may devote the actual composition to writing facts, rather than to trying to dig up abstruse thoughts which do not exist in their minds. The opportunity afforded for our youth to know more not only of various aspects of outdoor life, but of our greatest industry and of our most numerous industrial class is important. Not only is it of advantage for city youth to have clear conceptions of farms and farmers, but it is important that country youth should know more of other farms and of the farmers of other communities.

W. M. Hays

U. S. Department of Agriculture

Zur Biologie des Chlorophylls. Laubfarbe und Himmelslicht. Vergelbung und Etiolement. Von E. Stahl, Professor in Jena. Jena, 1909.

Professor Stahl is one of the foremost botanists of that school of biologists which attempts to interpret the facts of nature on the hypothesis that everything which endures is useful, that the qualities of an organism which are useless or harmful presently disappear or cause the organism to disappear in the struggle for existence. In the present contribution to philosophical biology Stahl has selected for consideration a subject of prime importance: Why are plants green, why are the organs in which plants manufacture food from inorganic materials green?

It is remarkable that the plants of the earth's surface are green or have green leaves. Few land plants are otherwise colored; the plants living below low-tide mark are, generally speaking, red; many plants between the tide marks, or close to the surface of the sea, are more or less olive, that is, greenish-brown; a large group of more or less unicellular algæ, living on damp soil or in shallow water, both fresh and salt, are olive-brown. Certain bacteria, constituting a small group, are purplish-red. Green is, then, the predominant color of the vegetation of land and sea. And one is disposed to believe that this has always been the case since plants came into existence.

The manufacture of food by plants depends upon energy acquired by absorbing light. The materials first used in manufacturing food are water, of which there is a more or less abundant supply wherever plants exist, and carbon dioxide, of which there has been for ages only a very meager proportion in the atmosphere. The supply of carbon dioxide is practically constant, the supply of water variable both locally and generally, the supply of energy, of light, varies daily, varies locally. The process of food manufacture depends, then, upon two variables and one constant, but the constant is very small in proportion to the other ingredients of the air. I wish to emphasize the small proportion of CO_2 in the air, for unless one realizes this, one will fail to understand why plants, by absorbing more of the available solar energy, could not improve their present case. In fact, one criti-

cism of this paper of Stahl's which may be suggested is that he does not appear to take this small proportion into account.

The color of plants is due to the translucent screen of chlorophyll which absorbs the less and the more refractive rays in sunlight, but does not absorb the green and yellow rays in anything like the same proportion. "Hence leaves appear yellowish-green because the greater part of the red, orange, blue and violet are absorbed by the pigments of the chromatophores." Greater absorption would increase the risk of injuring the leaves by overheating. Under present conditions the absorption of energy from direct sunlight exceeds the amount used in food manufacture. If, however, the proportion and the amount of CO_2 available were greater, a larger proportion of the energy absorbed from direct light would doubtless be used, converted into work, in the manufacture of food, and the possibility of overheating would be less. In diffuse light, on the other hand, the available energy is less while the supply of the food materials remains the same. That the energy supply may be disproportionately small is obvious. Stahl sees, therefore, in the chlorophyll pigments a means of absorbing a due proportion of the energy available in diffuse light. He then proceeds to consider the effect of the atmosphere on sunlight, both the absorption of rays of certain sorts and also the diffusion of what remains.

The majority of botanists live in an atmosphere to which, besides the natural addition of water-vapor, unnatural additions are constantly made, namely, smokes and dusts of various kinds. These three additions, water-vapor, smokes and dusts, increase the amounts and somewhat change the proportions of sunlight naturally absorbed by the atmosphere. One need only mentally contrast the atmosphere of Pittsburgh, London and Leipzig with that of Italy, Arizona and California to realize how true this is. The quantity and the quality of the light reaching the earth's surface in these different places is affected accordingly. Natural air absorbs qualitatively and quantitatively less than unnatural air. Stahl claims that plants have adapted their color, their absorbing agents, to light naturally impoverished in its passage through pure air. The color of leaves is due to a mixture of yellow and green pigments, *complementary* to the dominant colors of the lights in nature. The yellow and orange components, consisting mainly of carotin, are complementary to the blue light of the sky; the green components are complementary to the red and orange which impress us as predominant only when the sun is low, early or late, and its light traverses the atmosphere.[1] This is Stahl's main thesis, to which he recurs again and again.

After this study of the relations of the chlorophyll pigments to the composition of ordinary sunlight there follows a discussion of the adaptations of plants, aquatic as well as terrestrial, to the illumination. These adaptations or adjustments are to the physical as well as chemical properties of sunlight, to heating as well as to food manufacture. It is pointed out that the physical effect of intense illumination may consist in overheating the protoplasm itself or in producing excessive evaporation, which Stahl calls transpiration. These are guarded against in a variety of ways interestingly described. The reaction of the chromatophores themselves to various intensities of light is shown, by reference to Stahl's own earlier work and to the work of others, to consist in changes in the position of the chromatophores and in a "regulation" of the quantities and kinds of pigments in them. Thus Stahl describes the changes of shade or color in insolated parts of plants—in the ordinary green land plants, *Fucus* and other brown sea-weeds living between the tide-marks, the green algæ of fresh and salt water, of the surface or below, the peculiar blue-green algæ which live on mud, etc.

Then comes a study of etiolation, the turning white or the remaining white of plants or plant-parts in the dark. This phenomenon has so frequently been the subject of observation and reflection that, each time it is mentioned, it becomes clearer how little is really known

[1] Stahl's words, "durch das *trübe* Medium der Atmosphere," I find myself unable to translate exactly.

about it. Stahl, recording that the seedlings of all gymnosperms except *Gingko, Welwitschia, Cycas* and *Ephedra* are green even when the seeds sprout in the dark, expresses the suspicion that this fact may have phylogenetic significance. It may; but to the reviewer such speculations, such suggestions, savoring more of the study than of the laboratory, are of little use to science. On the other hand, Stahl did not ascertain whether or not there might be differences in the amounts of light reaching the developing embryos in the ripening seeds of these different classes of gymnosperms. He points out earlier in this paper that the seedlings of maple, etc., which are green in darkness, spring from seeds not covered by opaque coats while they are ripening. Thus we do not know that seeds of pine, for example, if made to mature in darkness on the tree, would not yield as colorless seedlings as those of *Gingko, Welwitschia* and the other "living fossils" if similarly sprouted in the dark.

The next chapter is on the autumn yellowing of leaves. Here are recorded or quoted analyses indicating the differences in the content of leaves before and after the autumn change takes place. Thus in equal pieces of the same leaves cut out (by cork-borer) before and after yellowing there is found to be little change in the proportions of magnesium, an increase in calcium, sodium and sulphur, a decrease to one half in nitrogen, phosphorus, potassium, iron, chlorine and silica. The significance of these facts is thus interpreted: the yellow constituents of chlorophyll are composed of elements which are abundant and easily obtained, whereas the green pigments consist of less abundant elements less easily obtained; so, in yellowing or in etiolated parts, the green is withdrawn or is not formed, and there is a corresponding *economy*. Whether one will agree with this conclusion or will dissent from it will depend upon whether one has, as Stahl himself points out, the ecological or the physiological point of view.

Stahl's paper on chlorophyll is a valuable contribution to the subject. It contains many references to the abundant literature; it suggests both further reflection and more work in the laboratory. It is stimulating, perhaps more so because it is not convincing.

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Tuberculosis, a Preventable and Curable Disease, Modern Methods for the Solution of the Tuberculosis Problem. By S. Adolphus Knopf, M.D. 8vo, pp. 382, with 115 illustrations. New York, Moffat, Yard and Company. 1909. $2.20 by mail.

Dr. Knopf is the author of numerous monographs on medical, sociological and hygienic subjects. The present volume will be welcomed as it deals in a thorough and most satisfactory manner with one of the most important problems of the human race. This was to be expected from the author of the essay "Tuberculosis as a Disease of the Masses, and How to Combat it," which was originally written in German and received the International Prize from the Congress on Tuberculosis held at Berlin, May 24–27, 1899. Dr. Knopf's essay has since appeared in twenty-seven editions and almost as many languages. The book before us is destined to play a very important rôle in the crusade against a disease which carries off more victims than any other human affliction. It is intended by the author to be helpful to the patient, the family, the physician, the sanitarian, to municipal and health authorities, legislators and statesmen, employers and employees, the public press, professors and teachers, clergy, philanthropists, charity organizations and the people at large. Chapters I. and II. deal with what the patient should know concerning the disease, more especially the nature of the disease, the various channels of infection, such as by inhalation, droplet infection, infection from food substances and infection by inoculations; of these the first two are doubtless the most common modes of infection, while the danger from infected food and inoculations can not be entirely ignored. It is well that the author emphasizes the danger from droplet infection. It

was shown a few years ago by Professor Fluegge and his co-workers, that tuberculous patients, in coughing and sneezing and also in speaking, project into the air within a distance of two and one half to three feet small droplets of saliva containing fresh and virulent bacilli, which when inhaled constitute a special source of danger, unless the patient takes care to hold his hand or handkerchief before his mouth. It is held by many, and we believe correctly, that droplet infection is even more dangerous than the inhalation of infected dust. The author describes very lucidly the methods of the four sources of infection and points out that the touch of the clean conscientious consumptive can not give tuberculosis to others. Chapter III. deals with the duties of the physician towards his patient, the family and the community at large. We heartily endorse the opinion of the author that it is wrong, if not a criminal neglect, to hide from an intelligent adult the fact that he is tuberculous or that a member of his family is affected with the disease.

All that is required is tact, and the task of inspiring confidence is not difficult when we can assure our patients that with proper cooperation and treatment over 80 per cent. of cures of incipient cases have been reported. The chapter also contains excellent suggestions for leaflets of instruction, inauguration of general preventive measures, when to send patients away, maxims in the choice of climate, selection of occupation for persons predisposed to tuberculosis, compulsory notification, disinfection of the sick room, the treatment of the patient's mind, etc. The author very properly favors notification of tuberculous cases to the health authorities, so as to locate the sources of infection, to trace and remove the underlying causes of the prevalence of tuberculosis and last but not least resort to disinfection of the premises upon the death or removal of the patient.

The author's twelve maxims on the subject of climatic treatment are sound and should receive careful consideration by physicians and patients. We fully endorse his strong opposition to sending an impecunious patient to a far-away climate in the hope that in a few weeks he may find light employment, when as a matter of fact he is likely to swell the number of inmates of the hospitals and charitable institutions of the far west. Chapter IV. is of special interest, as it tells us in a most instructive manner how the sanatorium may be adapted to and initiated in the home of the consumptive. In view of the fact that over 90 per cent. of our cases are either too poor or otherwise unsuitable for climatic cures, the practical value of this chapter must be apparent. Indeed we are beginning to realize more and more that while certain climatic conditions are valuable as auxiliary factors, our main dependence is after all an abundance of pure air, and a hygienic and dietetic regimen.

Chapter V. tells us in a most interesting manner how sanitation and proper housing conditions may aid in the prevention of tuberculosis. We quite agree with Dr. Knopf that unsanitary dwellings, overcrowding, lack of pure air and sunshine, are most important predisposing factors to the disease.

His views of the effects of polluted air in the cities, workshops and dwellings, and his plea for wide streets and lower buildings, sanitary houses and model tenements, should be heeded, since general sanitation constitutes one of the most effective weapons in the combat against the disease. The present writer has recently studied the general movement of tuberculosis in this country and Great Britain and finds that the death rate from tuberculosis in Washington has fallen from 446 per 100,000 of population in 1880 to 280 in 1907. In New York City from 433 to 271. In the United States at large from 326 to 183. In Great Britain and in Massachusetts the reduction since 1850 amounts to over 50 per cent. These reductions began long before the combat of the disease was a subject for popular education and are coincident with the introduction of sewers, improved water supplies and the erection of sanitary homes. The marked reduction in the prevalence of consumption after the introduction of sewers observed in England and elsewhere may, to a great extent, be

attributed to the prevention of air pollution and dampness. It is noteworthy that while the reduction in the city of Washington coincident with the introduction of sewers amounts to 37.3 per cent., the reduction in Baltimore, an unsewered city, is only 24.7 per cent.

Erismann has calculated that a cesspool with 18 cbm. contents is capable of polluting the atmosphere in the course of twenty-four hours with 18.79 cbm. of impure gases and it requires no great stretch of the imagination to calculate the amount of air pollution which resulted from the cesspools and other makeshifts prior to the introduction of the sewerage system. The relation of dampness to consumption may be explained as follows: Sewers help to drain the soil. Dampness of soil, unless special precautions have been taken, extends by capillary attraction to the walls and renders the entire house damp. Damp air abstracts an undue amount of animal heat, lowers the power of resistance of the inmates and predisposes to catarrhal affections and these in turn render the mucous membranes more vulnerable to the invasion of the tubercle bacilli. There is also reason for believing that the bacilli retain their vitality for a greater length of time in such an atmosphere on account of its humidity and excess of organic matter. At all events it has long been known that tuberculosis is far more prevalent in damp, dark and unsanitary houses. It is difficult to explain how pure water is connected with the deaths other than those from waterborne diseases, yet when we consider that water enters into the composition of the human body to the extent of 60 per cent., we are in a position to appreciate the sanitary acumen of Aristotle when he wrote in his "Politica": "The greatest influence on health is exerted by those things which we most freely and frequently require for our existence, and this is especially true of water and air."

Chapters VI. and VII. deal with the duties of municipal, state and federal health authorities in the prevention of the disease. Dr. Knopf's presentation of what has been accomplished and his many valuable suggestions as to what more needs to be done are of interest and importance. Chapter VIII. enters very fully into the subject of factory and office hygiene—tuberculous employees and servants, general railway sanitation, the farmer's duty in the prevention of tuberculosis in man or beast—and is replete with valuable facts and recommendations. Chapter IX. is one of the most important of the series, dealing as it does with the duties of school teachers, educators and the public press in the combat against tuberculosis. He makes a strong and just plea for school sanitation with special reference to ventilation, lighting and heating, gymnasia, playgrounds and swimming pools and offers many valuable suggestions to those entrusted with the physical development of the nation's most valuable assets. Dr. Knopf offers an alphabet suited for the understanding of younger pupils, in which he points out "the numerous sources of tuberculous infection to which the child may be exposed at school and what the child itself can do to overcome the possible sources of infection." This alphabet should be adopted, as it will prove of immense benefit to the present and future generations, without exciting an undue fear of the disease. The author's description of scrofulous children and those predisposed to the disease, and his plea for open-air schools for such children, should strongly appeal to all educators.

Chapter X. deals with church hygiene, hospitals, cremation, the Emmanuel church movement, value of cooperation in anti-tuberculosis work, need of sanatoria for tuberculous children, sanatoria in the United States and illustrations of different types, social and medical mission of the sanatorium, philanthropic consumptives, day and night camps, class methods, etc. Chapter XI. deals very fully with the duties of the people in the combat of tuberculosis, the early signs of the disease recognizable by the laymen, educational methods by free lectures and literature, overcoming an inherited tuberculous predisposition, hygiene of pregnancy, nursery hygiene, dress and hygiene for children, tight lacing, child labor, alcoholism as a predisposing factor in the disease and its prevention. The author, while a

strong advocate of temperance, is opposed to prohibition and in favor of the Gothenburg system, educational methods and the creation of clean and wholesome amusements calculated to counteract the evil influence of saloons; we heartily endorse his general views on the alcohol question and his opposition to the pernicious system of treating. We regret that Dr. Knopf, an evident believer in home-making, did not emphasize the value of good wholesome food as a preventive factor in alcoholism, especially since the cold dinner pail and badly prepared food create an appetite for alcoholic beverages. In Chapter XII. the author discusses the prospects of the ultimate eradication of tuberculosis and quotes two encouraging sentences from the writings of Pasteur. Dr. Knopf has shown that tuberculosis is a preventable and curable disease—we firmly believe that if the measures recommended by him in his book, and which have been known to sanitarians for some time, were generally adopted, the great "white plague" which now carries off annually over 150,000 victims in the United States alone would be eradicated within one or two generations.

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SCIENTIFIC JOURNALS AND ARTICLES

The Journal of Experimental Zoology, Vol. VII., No. 1 (August, 1909), contains the following papers: "The Production of New Hydranths in Hydra by the Insertion of Small Grafts," by Ethel Nicholson Browne. A stock hydra may regenerate a new hydranth in region of graft if (1) a tentacle with peristome tissue at its base, or (2) just peristome tissue without the tentacle, or (3) regenerating head material, or (4) bud tissue, is grafted in any region except the tentacle region. In the foot region, the new hydranth pinches off as a minute hydra of about one tenth normal size. In and above the middle region, the new hydranth is of normal size. The origin of regenerating material and the fate of absorbed material is shown by grafts of normal green with artificial white hydras. "The Effect of the Destruction of Peripheral Areas on the Differentiation of the Neuroblasts," by M. L. Shorey. The purpose of these experiments was to study the behavior of portions of the developing nervous system when it is itself left quite intact and with all its relations normal, but with the primordia of the organs which it should innervate extirpated before innervation. In every instance it was found that the neuroblasts do not differentiate except in the presence of their normal end organs, or of others of a similar character. "Factors of Form Regulation in *Harenactis attenuata*, II., Aboral Restitution, Heteromorphosis and Polarity," by C. M. Child. In the esophageal region of the actinian *Harenactis* tentacles form at both oral and aboral ends of isolated pieces, but at all levels proximal to the esophagus tentacles appear orally and a foot aborally. The two internal factors determining the polar phenomena are the constitution at the various levels of the body, and the physiological correlations between the parts composing the piece. "Some Effects of External Conditions upon the White Mouse," by Francis B. Sumner. The most important conclusions from these experiments are (1) that certain readily measurable structural modifications have been produced by changes of temperature, corresponding to some of the differences between northern and southern species or varieties of mammals; and (2) that there is a distinct tendency toward the reduction of these experimentally produced differences during subsequent growth, even when the conditions which gave rise to them remain unchanged. "Further Observations of the Behavior of Tubicolous Annelids," by Chas. W. Hargitt. The paper supplements earlier observations and experiments by the author on the behavior of this interesting group of annelids, tabulating in considerable detail the various reactions. It also emphasizes the importance of behavior under natural, as compared with artificial, conditions, and points out the important significance of the complex aspects of the tubes themselves as expressions of behavior. The results fail to show any evidence in support of the so-called tropism theory of behavior.

The Journal of Biological Chemistry, Vol. VI., No. 5, issued September 16, contains the following: "On the Decomposition of β-Oxybutyric Acid and Aceto-acetic Acid by Enzymes of the Liver," by A. J. Wakeman and H. D. Dakin. An enzyme, "β-oxybutyrase," was detected in liver tissue which, in the presence of oxygen, converts β-oxybutyric into aceto-acetic acid. Another enzyme was detected which decomposes aceto-acetic acid. Conditions influencing their action were studied. "The Leucin Fraction of Proteins," by P. A. Levene and Donald D. Van Slyke. The substances l-leucin, d-isoleucin and d-valin, which make up the leucin fraction in the hydrolysis of protein, may be quantitatively separated from each other by transformation into the lead salts. "The Leucin Fraction in Casein and Edestin," by P. A. Levene and Donald D. Van Slyke. Quantitative estimations of l-leucin, d-isoleucin and d-valin resulting from the hydrolysis of casein and edestin. "The Nature of the Acid Soluble Phosphorus Compounds of Some Important Feeding Materials," by E. B. Hart and W. E. Tottingham. A study of the distribution of phytin and inorganic phosphorus in corn, oats, barley, rutabagas and alfalfa hay. "A Volumetric Method for the Estimation of Casein in Cow's Milk," by E. B. Hart. The method consists in measuring the amount of standard alkali neutralized by the casein from a measured sample of milk. "On Preformed Hypoxanthin," by V. N. Leonard and Walter Jones. Preformed hypoxanthin, *i. e.,* that not formed from adenin by action of adenase, is present in all tissues, especially in muscles, and contributes largely to the endogenous uric acid of the body. "The Intracellular Enzymes of Lower Fungi, Especially those of *Penicillium camemberti,*" by Arthur Wayland Dox. From *Penicillium camemberti* enzymes were separated capable of decomposing certain proteins, nucleic acid, amides and amido-acids, glucosides, esters and carbohydrates.

THE Higher Education Association, whose office is at 42 Broadway, New York, has begun the publication of a monthly magazine entitled *The American College.* In addition to editorial articles and various departments, the first issue contains the following articles:

"The Carnegie Foundation's Dual Mission": F. B. Lawrence.

"Sensational Attacks on University Teachings": Edwin E. Slosson.

"College Bookkeeping and Accounting": Clarence F. Birdseye.

"A Victorious Defeat" (Story): George Thomas.

"The Moral Ideal and the Pursuit of Knowledge": Francis J. McConnell.

The directing editor of the journal is Mr. Clarence F. Birdseye, known for his books on "The Reorganization of our Colleges" and "Individual Training in our Colleges," and the managing editor is Mr. Frank F. Rogers. The Higher Education Association was incorporated in the state of New York last May. The first of the purposes of the corporation, according to the charter, being "to improve higher education throughout the United States, and in particular the internal and external conditions of the American college, by furnishing an agency and funds whereby a careful study can be made, and improvements can be brought about in the institutions of higher learning." The directors of the corporation are: Colonel C. E. Sprague, the Hon. George B. Cortelyou, Mr. Clarence F. Birdseye, Dr. E. E. Slosson, Dr. Virgil Prettyman, and Mr. Arthur H. Pogson.

THE editor of the *Monthly Weather Review* announces that beginning with the issue for July, 1909, the *Review* will be restricted to statistical tables of general climatological data for the United States. The relatively small amount of accompanying text will summarize the weather conditions of the month in the different districts. It is thus evident that hereafter the *Review* will be of value only to those advanced students of climates, engineers, etc., who need detailed data for their own discussion. Few papers of general interest to teachers, except as related to climatology, will be published in the *Review,* and it is not probable that the publication will be of value to those public schools and high schools that have been receiving it heretofore. The scope of the articles appearing in the Mount Weather

Bulletin will be limited to technical treatments of subjects of advanced research. This will make most of the articles of that publication also beyond the comprehension of the average pupil of the above grades of schools, and make the bulletin only appropriate for the libraries of colleges and universities.

SPECIAL ARTICLES

THE PERFECT STAGE OF LEAF-SPOT OF PEAR AND QUINCE

It is well known that the "leaf-spot" of the pear and quince is caused by an "imperfect fungus" called *Entomosporium maculatum* Lév. The perfect stage, however, is not so well known, although it is probably very common in both Europe and this country, but may be easily overlooked. It occurs quite abundantly on the leaves of the pear and quince, affected with the disease, which have lain on the ground during the winter. Such leaves are very commonly affected in the spring with species of *Sphærella*, as *S. sentina* and *S. pyri*. These two species are also "perfect" stages of fungi, but very different from the perfect stage of the leaf-spot caused by *Entomosporium*. Their fruit bodies are black and project slightly from the surface of the dead leaves and thus are quite conspicuous objects even on the dry leaves when examined with the pocket lens.

The fruit bodies of the perfect stage of *Entomosporium* are, however, usually very inconspicuous and are not easily, if at all, recognized with the aid of a pocket lens, in the dry state, because they are collapsed. When the leaves are wet, however, and the fruit bodies are mature, their contents are swollen and thus crowd apart the thin wall and expose the white tips of the asci in a more or less elliptical area. This character of the fruit body shows that the fungus is one of the Discomycetes. The asci are eight-spored, the spores hyaline and two-celled, while the asci are accompanied by paraphyses. Sorauer[1] first called attention to the perfect stage of *Entomosporium* on leaves of *Cotoneaster tomentosa* and *Pirus communis* silv., but placed the fungus in the genus *Stigmatea*, one of the Sphæriales closely related to the *Sphærella* but differing chiefly in the possession of paraphyses.

Twelve years ago I called attention to this perfect stage which I found on quince leaves at Ithaca, and identified as *Fabræa*,[2] at the same time pointing out how easy, under certain conditions, it might be to mistake it for a *Stigmatea*. The connection of the fungus with the *Entomosporium* by Sorauer was assumed because it follows the *Entomosporium* during late autumn and in the spring in the same tissues of the leaf. While I have several times grown the *Entomosporium* from quince fruit in pure cultures, I have never obtained the perfect stage in these cultures. I have, however, carried the cultures in the opposite direction, by obtaining the *Entomosporium* in pure cultures from ascospores of the *Fabræa*.

I hope before long to publish a full account of these studies, but in the meantime it seems desirable to indicate the name of the fungus in its new position. Sorauer's studies were concerned with *Entomosporium mespili* (DC.) Sacc., and he employed the name *Stigmatea mespili*[3] (DC.) Sor. This fungus would therefore be *Fabræa mespili* (Sor.) while the one I have worked with (*Entomosporium maculatum* (Lév.)) becomes *Fabræa maculata* (Lév.). There is a strong probability that these two species are identical, since the only difference between *Entomosporium maculatum* Lév., and *E. mespili* (DC.) Sacc., aside from differences in size of the spores and these will not, it appears, hold, as given in the descriptions, is that the lateral cells of the spore are depressed in the former, while they are a little larger and more rotund in the latter.

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[1] "Pflanzenkrankheiten," Zweite Auflage, 2, 372–377, 1886.

[2] "Leaf-spot of Pear," *Garden and Forest*, 10, 73–74, 1897.

[3] *L. c.*, p. 371. See also Sorauer, P., "Handbuch du Pflanzenkrankheiten," Dritte Auflage, 2, 237, 1908, where the perfect stage is given as *Stigmea mespili* Sor.

NOTES ON TWO COMMON TURTLES OF EASTERN UNITED STATES

THE speckled tortoise (*Clemmys guttatus*) Schneider is one of the commonest and most conspicuously colored turtles of much of the eastern United States. Its shell or carapace is smooth, black, with a sprinkling of round, orange-yellow spots. The plastron is yellowish with darker markings. This pretty turtle is largely aquatic in its habits, but is frequently found wandering among the vegetation of wet, swampy grounds. This turtle is, without doubt, of considerable economic value, as shown by the published data of its stomach contents determined by the Zoological Division of the Pennsylvania Department of Agriculture. It is here proved that this turtle is mainly insectivorous in its feeding habits, and for this reason deserves to be protected.

Concerning the food of this species, a number of the early writers state that it captures frogs. There is little doubt but that frogs occasionally enter into its diet. I myself once watched one of these turtles pursue a small frog very actively in a brook at Oxford, Mass. At that time an excellent observer also informed me that he saw one of this same species capture a small frog.

Another interesting turtle is the wood turtle (*Clemmys insculptus*) LeConte, not infrequently met with in the eastern states. It is very largely terrestrial in its habits, and may frequently be found wandering through dry woods and fields far from any water. In New England, late in winter and in March, I have captured numbers of these turtles, near Charlton, Mass. In spring and summer it extends its wanderings into the upland fields and woods. During the period of spring fires, I have frequently found this turtle burned to death in dry woods and fields, where it had been overtaken by brush fires.

Several years ago at Oxford, Mass., I carried one of these turtles to a point in a pasture near my home, in order to observe some of its feeding habits. Set free, the turtle headed for a dry, rocky pasture, across which extended a portion of a steep cliff. It pursued a course directly toward this cliff. I followed cautiously a few feet behind, on my hands and knees, keeping immovable if the turtle turned its gaze toward me. In this manner I spent the entire afternoon observing this turtle, and learned a good deal concerning its food habits. It fed greedily on any mullein leaves (*Verbascum thapsus*) in its path, and seemed especially fond of common sorrel (*Rumex acetosella*). It climbed slowly up the grassy banks bordering the cliffs, and finally gained a spot where grew various weeds and shrubs in the loose soil and rock crevices. When several feet away, its keen eye spied some large, red wild strawberries on a certain bank. It was interesting to see how eagerly and hurriedly it scrambled toward these berries. It spent considerable time among them, reaching up and clawing down the plants in order to reach the berries which it raked off awkwardly, together with the leaves, into its jaws. Later, its course led toward a swamp.

The food of this turtle is largely of vegetable composition, although varied animal matter consisting of insects, molluscs, etc., is eaten, as shown by examinations of its stomach contents by the Pennsylvania Department of Agriculture. Feeding largely as it does on all sorts of vegetable matter—leaves, berries, etc.—it no doubt incidentally includes more or less insects and slugs which may be present at the time, especially on those lower portions of the plant accessible to it.

I have frequently found females of the wood turtle excavating holes and laying eggs in early summer, in sand beds washed in by overflows of the Maanixit River at Oxford, Mass., and in the bare, loose sandy soil of more upland situations.

As a class the habits of our turtles need considerably more attention, in order to make us better acquainted with their economic position with regard to agriculture. If it is shown that they are, as a class, beneficial as destroyers of vermin and noxious insects, etc., then they must be considered one of the natural agencies tending to promote agricultural interests just as much as the useful birds and

toads, and for that reason we owe them every protection.

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ON ARTIFICIAL PARTHENOGENESIS OF THE SEA-URCHIN EGG

FROM July 1 until now I have been studying artificial parthenogenesis in *Arbacia punctulata*. I succeeded in rearing the larvæ made parthenogenetic by treatment with carbonated sea-water (5 minutes) followed by hypertonic sea-water (about 30 minutes) for several weeks in Roscoff filter-aquaria. At the end of a month there were so few alive that I did not consider further attention to them worth while, owing to the possibility (though improbable) of contamination with foreign plutei when renewing the water (that was dipped up daily at the end of the wharf at high tide). I found no constant difference between parthenogenetic and fertilized larvæ.

It thus being doubtful that I could produce sexually mature adults parthenogenetically, I confined my further studies to early phases. J. Loeb considers the essential event in artificial parthenogenesis to be the production of a free-swimming embryo or larva—but why larva rather than any other stage. In natural parthenogenetic development the end result may be a maturation or segmentation stage or a larva or adult. Though only the reproductive adults are of significance to the species, all are of significance to science. It might also be remembered that Loeb's parthenogenetic *Chætopterus* "larvæ" were unicellular structures, resembling trochophores only in the possession of cilia and by an irregular redistribution of cytoplasm, and were incapable of further development.

In *Arbacia punctulata* maturation takes place in the ovary, but no segmentation occurs without fertilization or an artificial stimulus. The ovarian egg is surrounded by a thick coat of a jelly-like proteid that swells slightly and gradually dissolves in sea-water. It is practically invisible, but can be located by adding to the medium, Chinese ink, the particles of which stick to its surface. The inner surface of the jelly fits tightly against the egg. The jelly is stained by neutral red or methylene blue, which causes it to contract and pull away from the egg. Acids cause it to contract and become more dense and sticky. Tannin coagulates it into a coarsely granular yellowish mass. Alkalies cause it to dissolve more rapidly, as does also agitation. When the egg is fertilized or put in "membrane-forming" solutions a fluid is extruded which pushes the jelly out from the surface of the egg. The inner surface of the jelly is then sharply defined and is probably bounded by a thin membrane (the "fertilization-membrane") as spermatozoa wriggle freely through the jelly but can not pass its inner surface.

As membrane formation does not occur in all parthenogenetic *Arbacia* eggs it was considered of secondary importance. The next change seen in developing *Arbacia* eggs is the migration of the red pigment plastids to the surface. I first thought this due to the formation of asters, but on sectioning could find none. In the living egg these plastids take up neutral red or methylene blue before other parts of the egg, and in fixed material stain with Delafield's hæmatoxylin stronger than other parts of the cytoplasm. Parthenogenetic reagents when used in sufficient concentration cause the pigment to diffuse out of these plastids into the surrounding cytoplasm and from it into the sea-water, showing that both plastid membrane and cell plasma membrane are permeable at this time.

Loeb showed a similarity between hæmolysis and artificial membrane formation. It has long been supposed that hæmolysis is due to an increased permeability of the plasma membrane as hæmoglobin diffuses out. Ralph Lillie supposes artificial parthenogenesis and stimulation to be due to an increased permeability of the plasma membrane. This assumption is supported by my observation of the diffusing out of the pigment in the *Arbacia* egg.

Repeating the experiments of others and making new ones, I tried various types of agents that cause hæmolysis or stimulation to see whether they caused parthenogenetic development in *Arbacia*. I succeeded in causing segmentation by isotonic NaCl and by the

following chemicals and conditions in sea-water: acids, alkalis, hypertonicity, hypotonicity, ether, greatly diminished oxygen, potassium-cyanide, heat, cold, induction shocks and mechanical agitation. In many cases the eggs segmented while they remained in the artificial solution. They would not segment in sea-water charged with carbon dioxide unless most of the gas were allowed to leave the sea-water. They segmented in weak alkalis, hypertonic sea-water, diminished oxygen, KCN and cold.

From the above we may conclude that the various parthenogenetic agents could not have a similar chemical action and must have some common physico-chemical action, most probably changing the permeability of the plasma membrane, thus allowing the escape of carbon dioxide (as suggested by Lillie). The fact that eggs will not segment in concentrated carbon-dioxide demonstrates the last point. Lyon showed that the escape of carbon-dioxide from sea-urchin eggs varied rhythmically during cleavage, which suggests that a period of increased permeability is necessary for each cleavage. The stimulus to parthenogenetic development need only be applied once and the egg becomes automatic like any other cell.

The question arises whether these agents have any additional effect besides changing the permeability of the membrane. When the membrane becomes permeable some of the reagents must enter the cell. Probably this is the reason that some reagents start development that continues indefinitely, whereas after others development soon ceases (the eggs being injured by the reagent). Some chemicals may cause an irreversible permeability that does not initiate segmentation but causes death, but these will not be considered. It seemed to me that if the reagents caused a simple physical change, one could be made to act as quickly as another by finding the proper concentration, and this I tried to do. Fifteen seconds' exposure was sufficient with acetic acid while about seventeen hours was necessary with potassium cyanide. It is evident that the actions of the two are different. Probably the KCN slowly enters the egg while the membrane is relatively impermeable and by retarding certain enzyme actions brings about increased permeability of the membrane. Or the KCN may make the membrane permeable immediately and then enter the egg, retarding the production of carbon-dioxide and thus necessitating a longer period of permeability.

Since the egg becomes automatic after one of a number of stimuli the question arises why it did not remain automatic like every other cell in growing regions of the mother. In studying the cell lineage of parasitic Copepods I found that the germ cells could first be distinguished from the soma cells by their slow rate of division. In the thirty-two cell stage, one cell is the primary germ cell and it does not divide as soon as the other cells do, but grows larger than they do. Probably its failure to become sufficiently permeable to divide as soon as the others allows it to grow larger and become the germ cell. This may be true of all its progeny and in the final generation, the primary oocytes, enormous growth takes place and division is impossible without a special stimulus. The plasma membrane may not be sufficiently permeable for cell division and yet allow the passage of nourishment. Perhaps fats and lecithin may enter the cell by dissolving in the lipoids of the membrane.

To sum up, we may conclude that all agents initiating parthenogenetic development in the egg of *Arbacia* cause increased permeability of the plasma membrane, but some agents act differently from others, either by having an indirect action or by producing additional effects.

J. F. McCLENDON

WOODS HOLE, MASS.,
Aug. 31, 1909

SOCIETIES AND ACADEMIES

AMERICAN MATHEMATICAL SOCIETY

THE sixteenth summer meeting and sixth colloquium of the society were held at Princeton University during the week September 13 to 18, 1909. The four sessions of the summer meeting proper occupied the first two days. Thirty-nine members were in attendance. At the opening session Professor Fine presided, being relieved at the later sessions by Professor Morley and Vice-presidents Kasner and Van Vleck. The following new

members were elected: Dr. L. S. Dederick, Princeton University; Dr. G. E. Wahlin, University of Illinois; Mr. E. E. Whitford, College of the City of New York. Eleven applications for membership were received.

It was decided to hold the annual meeting with that of the American Association at Boston. A grant of 5,000 francs was made from the treasury of the society in support of the proposed publication of the works of Euler. A committee was appointed to prepare suitable resolutions on the death of ex-President Simon Newcomb.

On Tuesday the members were conducted through the grounds and buildings of the university. Tuesday evening was marked by a reception at the house of Professor Fine.

The following papers were read at the summer meeting:

L. P. Eisenhart: "Congruences of the elliptic type."

Dunham Jackson: "Resolution into involutory substitutions of the transformation of a bilinear form into itself."

F. W. Reed: "On singular points in the approximate development of the perturbative function."

Virgil Snyder: "Surfaces invariant under infinite discontinuous birational groups defined by line congruences."

Joseph Lipke: "Natural families of curves in a general curved space." Preliminary communication.

A. S. Hawkesworth: "A new theorem in conics."

Anna J. Pell: "Applications of biorthogonal systems to integral equations."

G. C. Evans: "The integral equation of the second kind, of Volterra, with singular kernel."

Edward Kasner: "Triply orthogonal systems of surfaces."

Edward Kasner: "Natural families and Thomson's theorem."

G. A. Miller: "The groups which may be generated by two operators s_1, s_2 satisfying the equation $(s_1s_2)^\alpha = (s_2s_1)^\beta$, α and β being relatively prime."

F. R. Sharpe: "Integral equations with variable limits, with an application to the problem of age distribution."

R. D. Carmichael: "Note on a new number theory function."

T. E. McKinney: "On a criterion for λ-developments in the theory of equivalence."

G. G. Chambers: "Groups of isomorphisms of the abstract groups of order p^2q."

W. R. Longley: "Note on some periodic orbits with more than one axis of symmetry."

W. H. Bussey: "Tables of Galois fields of order less than 1,000."

W. B. Ford: "On the relation between the sum formulas of Hölder and Cesàro."

Oswald Veblen: "Products of pairs of involutoric projectivities."

G. F. Gundelfinger: "On the geometry of line elements in the plane with reference to osculating vertical parabolas and circles."

P. F. Smith: "Theorems in the geometry of surface elements in space."

R. G. D. Richardson and W. A. Hurwitz: "Note on determinants whose terms are certain integrals."

R. G. D. Richardson: "The Jacobi criterion in the calculus of variations and the oscillation of solutions of linear differential equations of the second order."

I. J. Schwatt: "Methods for the summation of infinite series."

A. B. Coble: "Cubic space curves that meet the Hessian of a cubic surface in six pairs of corresponding points."

G. D. Birkhoff: "On the theory of stability."

H. W. Reddick: "Geometric properties of a system of tautochrones."

W. B. Carver: "The poles of finite groups of fractional linear substitutions in the complex plane."

L. S. Dederick: "The solution of the equation in two real variables at a point where both the partial derivatives vanish."

H. T. Burgess: "On point-circle correlations in the plane."

H. B. Newson: "A general theory of linear groups."

A. R. Schweitzer: "A formal extension of Bolzano's series."

The colloquium opened on Wednesday morning. Two courses of four lectures each were given by Professor G. A. Bliss, on "Fundamental existence theorems," and Professor Edward Kasner, on "Geometric aspects of dynamics." Thursday afternoon was devoted to an excursion to Washington's headquarters at Rocky Hill.

The San Francisco section of the society held its regular meeting at the University of California on September 25. The next meeting of the society will be held at Columbia University on October 30.

F. N. Cole,
Secretary

SCIENCE

FRIDAY, OCTOBER 8, 1909

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE REHABILITATION OF THE AMERICAN COLLEGE, AND THE PLACE OF CHEMISTRY IN IT[1]

THERE are two subjects which at present occupy the focus of public interest in the United States; namely, the American tariff and the American college. One difference between the situations in the two cases seems to be that whereas a few people are strongly in favor of the tariff, nobody has a good word to say for the college. Perhaps a reservation should be made in regard to the latter; one senator, apparently, thinks that the negative quality of inefficiency is better than none at all. His words are: "I love my *alma mater* for all she has enabled me to be and to do, in spite of herself." He finds virtue in her very laxness.

Can we as chemists confidently feel that Flexner and Birdseye in their voluminous writings, and the myriad commencement orators in their more or less seasonable outpourings, have all spoken with a definite mental reservation? Can it be that all the unpleasant things that they have said were intended to apply to the whole structure of the American college, with the sole exception of its department of chemistry? I fear not. If then the American college is an Augean stable, shall we wait in the hope that some Hercules will come and clean it all in twenty-four hours, or shall we take off our coats and tackle the problem of our own stall?

[1] An address before the Section of Education of the American Chemical Society, at the Detroit meeting, July, 1909.

THE OLD COLLEGE AND THE NEW

The early American colleges suffered from no such torrent of criticism. For a time, indeed, some of them were blamed because they raised money for religious instruction by means of lotteries. But against the seriousness of their scholarship and the strictness of their discipline no voice was raised. The Latin, the New Testament Greek, the Semitic languages and the essay writings, sermon making, public speaking and debating, which practically filled the curriculum, were precisely the subjects required for their purpose. They were professional schools of divinity, and seventy-five per cent. of the graduates eventually became clergymen. Even to those who became lawyers and physicians, most of these subjects did not come amiss. The law was written in Latin and briefs and writs were prepared in Latin. Even the works on medicine were printed in the same tongue. The general appropriateness of the requirements was so evident that the student could not help being held fast, and could not help being carried along by the purposeful spirit of the place. Other learned institutions did not exist, and after a little more study, and some practical experience, the graduate was ready for his duties as preacher, lawyer or doctor.

Many changes, of which two may be mentioned, have altered the whole situation. In the first place, with the development of our knowledge along medical lines, and the greater demands made upon the lawyer and the clergyman, the college can no longer affect to be in any sense a professional school. It furnishes as much training in the same subjects as ever, in fact it furnishes more, but all that it does is so much smaller a fraction of the total professional course, that the purposeful state of mind of the professional student has entirely left its walls.

In the second place, the influx of another body of students will soon have reduced to a minority the proportion of its graduates destined to enter one of the learned professions. Only three or four per cent. of the graduates of Yale (formerly the official divinity school of the neighboring colonies) now enter the church, while forty per cent. become business men. Yet the American college has never attempted to be a professional school of business. Thus, by its failure to retain its old character as a professional school, the college has lost one of the main sources of its hold upon the interests of the student body. The colleges could not follow the development of all the professions, so they made no attempt to follow any. With the help of the elective system, they became bargain counters, or rather, since there was not always even a salesman specially deputed to give advice, the more advanced ones became mere automatic cafés.

Simultaneously with all this, the college has given up its attempt to form the character of its students by the enforcement of strict regulations. The student is no longer guarded against all temptation to form bad habits. He is no longer furnished with exercises and customs calculated to produce good habits.

Thus the college has relinquished its once effective plans for training professional men and for turning out men of character. The structures which performed these functions have fallen into disuse. The college as an educational institution is biologically a mere rudiment of a formerly vital and useful organ in the body politic. As one of its critics has said, "It is a sort of educational vermiform appendix."

Given an appendix, appendicitis is sooner or later bound to appear. We are now at

the bedside of the patient and, judging from the statements of numerous experts, the college appears to be the seat of a most violent inflammation. What is to be done with the victim of this appalling disease?

Analogy suggests that the offending organ might be cut off. But the American college, not being attached to anything, can not be removed. We might resolve to abolish the American college, but the American colleges would remain. And perhaps, after all, there is a place for the American college. The professional schools are rapidly adding a certain amount of college work to their admission requirements. It is true that some high schools have added two years to their curriculum, but the gap between the high school and the professional school is widening faster than it can be filled by the development of the secondary institutions. Here is still ample room for the American college.

THE COLLEGE A PLACE FOR CULTURE

We must regard as purely futile the suggestion that the college should be turned into a place for culture, if by this term is to be understood something distinct from scholarship. Flexner[2] quotes with approval the statement of Professor Mann, in which, after indicating the rigid nature of the work of technical students, he says:

> For the non-technical or general student, college laboratory work is neither essential nor desirable; the emphasis in this case should be laid upon the services of science in developing and maintaining intellectual, social and economic life.

An education composed entirely of this sort of work will not appeal strongly to chemists. Are not deep knowledge and rigid training in science required before the services of science in developing intellectual, social and economic life, can be properly appreciated? Is the giving of a culture course of this description not an attempt to produce *fruit* without the assistance of organs of nutrition and growth? Is a course which sets out with the definite aim of conferring culture, and nothing else, ever anything but a "soft snap"? Stimulating it may be, if given by an exceptional personality, but a good deal like the lemon phosphate and the ice cream soda, temporary in its effects. It pleases our palate for the moment and a week later is not even so much as a pleasing memory. I wonder if culture is not rather to be sought as a *by-product*—a by-product of cultured parentage and sound education—rather than as an end in itself?

THE COLLEGE FOR TEACHING PROBLEM-SOLVING

What important ends of subsequent life can the college course appropriately serve? Is not the chief exercise in every profession, and in all lines of business, that of solving problems?[3] Shall we not then so devise our methods of instruction that the student may gain experience in the exercise of this most important function. Shall we not teach him to suspend his judgment, instead of acting upon the first idea that comes into his head? Shall we not train him to search for facts, and to realize when essential facts are still lacking? Shall we not exercise him in correct reasoning from the facts when they have been secured? Shall we not, finally, show him the necessity for testing his conclusions by careful comparison with the facts and show him how to do this? This is no light program. Certainly no subject has gained a right to admission to the college course until it has demonstrated its capacity for being taught in this fashion.

[2] SCIENCE, N. S., XXIX., p. 366.

[3] See Professor A. A. Noyes's recent address, "A Talk on Teaching."

THE COLLEGE AS A PRE-PROFESSIONAL SCHOOL

So much for the general aim of the instruction. As regards the curriculum, would it not be well to hark back to the plan of the old college, with suitable modifications? The college can no longer furnish complete professional training, but it can do pre-professional work. It can do work of professional quality, so far as it goes. Let us exclude from the college rigidity all those whose aims are so indefinite that they are not willing to prepare for some profession. And I include banking, insurance and other lines of business amongst the professions, for, in spite of isolated opinions to the contrary, the college *can* furnish training in the sciences fundamental to business. Let the work be scholarly, exact and thorough. Let the chemistry and physics be a suitable foundation for further work in the same subjects, or for application in physiology and other more distinctly professional studies. Let the political economy prepare for more strictly professional courses in finance and transportation. If every student is engaged in one of these pre-professional curricula, shall we not be able in a large measure to restore the purposefulness of the old colleges? True, we can never reintroduce the regulations and restrictions which guided the life and moulded the character of the early undergraduate. But, if we require every student in college to select some one curriculum, and exact of him scholarly work in every study, shall we not so occupy his attention, that waste of time will be reduced to a minimum, and social occupations will be relegated to the subordinate position which alone they are entitled to occupy?

To avoid possible misunderstanding, let me add that by pre-professional curricula I do not mean narrowly specialistic curricula. With six or eight years available for the total pre-professional and professional training, there should be ample room for breadth as well as for intensity. What I mean is that the present more or less complete waste of the first part of the total course, which is so liable at present to occur, should be rendered impossible.

TWO CHANGES IN THE PRESENT SITUATION REQUIRED

If the American college is to be rehabilitated along these lines, namely, those of teaching problem-solving and giving work of professional standard, or along any similar lines, two important improvements in the present situation are required. To give in all subjects the kind of instruction indicated will require *skilful teachers*, and it is generally admitted that the teaching of undergraduates is at present less satisfactory than is that of the pupils in the grades and high school on the one hand, or of the students in the graduate on the other. The second need is that of *more efficient methods of teaching*, particularly in non-linguistic subjects.

TRAINING IN THE ART OF TEACHING NEEDED

The various causes of poor instruction in our college classes have been discussed at length by Flexner and Birdseye. I wish to speak of only one out of the whole number. When we desire the services of a physician we seek a man who has been trained in the practise of medicine. And when we employ a lawyer we entrust our business to one who has had training in the practise of law, and not to one who has a merely theoretical knowledge of the subject. Yet when we set out to find a college teacher, we enquire for a doctor of philosophy. The doctor of philosophy is a person who has devoted several years mainly to the study of one subject and often of a small corner of one subject. He is a per-

son who has had his attention for a time directed, with the utmost insistence, exclusively to the making of some addition to human knowledge. He may be an investigator, but he is not necessarily anything else. Training in the art of teaching is not even a minor requirement for the degree. We are constantly told that teachers are born, not made. So, however, are the most successful lawyers and doctors. This "nascent" theory of teaching will not bear a moment's scrutiny. What natural mechanism exists that shall direct the born teachers into teaching, and shall prevent the born policeman and born stock speculators from drifting into the same line of work? Then again, is the born teacher necessarily able to teach without training? The discoverer of an important surgical operation was probably a born surgeon, yet, unless the story is entirely apocryphal, he destroyed a whole hatful of eyes before he found out how to perform the operation successfully. Should we permit all other surgeons, including those of less native ability, to learn the art in the same way? Since the art can be, and is, taught in a more economical fashion, should we not regard the continual repetition of the original process as an unbearable atrocity? Shall we then allow even the born teachers, not to speak of those who are not of this select group, to mutilate the minds of our youth while learning their business?

No one has yet analyzed successfully the attributes of the investigator, on the one hand, and the attributes of the teacher on the other, and placed them side by side, in such a way that the extent to which they are congruent can be determined. But, that the *natural qualities* of the investigator should include all natural qualities of the teacher, and that other qualities which the investigation *acquires by training in research* should include the whole art of teaching, can not for a moment be believed. Perhaps an analogy may serve to bring out the distinction. We might train a man in the theory of music, and drill him in musical composition, so as finally, with the assistance of his natural ability, to develop a successful composer. Yet, if the requirements for the doctor of philosophy in music did not include anything more, we should be extremely foolish to infer that the graduate would be able to perform upon some musical instrument. He would be in the precise position of that classical person who did not know whether he could play the violin or not, because he never had tried. His position would be only a shade less absurd than that of the individual (commonly known as the college president) who, knowing the candidate had never been trained to play, nevertheless selected him to fill a position in the college faculty orchestra.

Of course I am aware that the president searches diligently for *teaching experience* amongst the qualifications of the candidates, and very often succeeds in detecting distinct traces of it. But teaching experience is one thing, and skill in teaching is another. The self taught analyst is a lottery, with the chances much against the gambler. He may have succeeded in teaching himself more bad habits than good ones.

It is hardly necessary for me to say that we should welcome the investigator and, other things being equal, prefer him in making a college appointment. In the college teacher, a keen interest in research and the ability to do it are indispensable. It is for some rational method of adding to the research ability, a certain amount of instruction in the art of teaching that I am pleading. Surely some method can be devised by which the prospective college teacher may get over the cruder blunders and mis-

takes of his first years of teaching, in circumstances in which less harm will be done to the student—and perhaps to the man's own reputation. If he has already taught, it should be possible to cure him of some of the worst habits he may have formed. One of our problems seems to me, therefore, to be the improving of the teaching in college classes by some system of training college teachers.

IMPROVED METHODS OF TEACHING NEEDED

If we are to give work in college up to the professional standard and in such a way that training to solve the problems of after life is to be given, we must have, not only skilful teachers, but improved methods of teaching.

The method of teaching languages, partly because of the nature of the subject, and partly as a result of long experience, has been brought to a high degree of perfection. The grammar furnishes the laws and general principles, together with all the known exceptions. The dictionary supplies the isolated facts in such a way that they can be most readily found. The text provides the subject of study in constant and definite form. The method of studying a language is extremely simple and is easily worked into the habit of thought of the pupil. He learns from experience to suspend his judgment in regard to the meaning of the author until he is in possession of the facts. He knows exactly where to look for the facts and what facts to look for. He learns to reason correctly, and the nature of the subject is such that he almost always knows when he has reached the correct conclusion. In other words, every conclusion is tested, and every element in problem-solving by the scientific method is covered. Mistakes, when he makes them, are sooner or later detected and rectified. The method is simple, yet of unquestionable efficiency.

A method so simple and certain has not yet been devised for history, literature, political economy or chemistry. Perhaps the successful study of these subjects can never be made so easy as in the case of languages. Yet it should, at least, be possible to detect the fundamental characteristics which make the study of language successful and adapt them to the teaching of other subjects.

THE LECTURE METHOD

Can it be said that any such successful method is used in chemistry? Is there, indeed, a general method of any description in use? Most commonly a course of lectures occupies a prominent place in the scheme of instruction, and an even more prominent place in the estimation of the student. The lecture method has its advantages. The facts can be presented more graphically than by any book. The relations of the facts can be explained with greater lucidity and in a more impressive manner. Illustrations can be multiplied, as they could hardly be multiplied in a book. Experimental illustrations, which are impossible in print, can be given. Yet who would feel that a lecture on twenty-five French words, no matter how brilliant, followed by other lectures of the same kind, with occasionally a lucid and interesting exposition of the meaning and application of some rule, would confer an ability to read, construe or speak French? After all, it is the *student* who has to *acquire* the French. By vigorous and persistent exercise, *the student* has to possess himself of it completely. One might almost as well attempt to make a change in the plumbing of one's house by talking to it, or to drive a golf ball by the use of language—alone, as to teach French by lecturing.

It too frequently happens, although it is not a necessary part of the lecture system, that the lecture is given by one who has no

contact with the laboratory work and perhaps pays no particular attention to what is being done in the laboratory. On the other hand, the laboratory work or the discussions may be conducted by one who is not in touch with the other two parts of the instruction. That confusion and waste of effort in such circumstances should arise is not to be wondered at.

LECTURE VERSUS DISCUSSION PREPARED FOR IN ADVANCE

As I have suggested before, the successful features of language teaching might be imitated where they are applicable. For example, in Latin, we teach not merely the language but, just as continuously and unremittingly, *we teach the method of studying the language.* I find that more than half of the students in a college class have not the faintest idea how to set about studying chemistry. They spend quantities of time, yet, for lack of a method, obtain very slight results. Should we not, for example, explain to them how to notice the significance of each word in a law, and to expand the succinct terms in which it is stated? Should we not insist on their connecting each law with a set of illustrations; enjoin them to apply each illustration closely to the law, word by word; and finally advise them to close the book and see whether they can recall the facts that led up to the law, reproduce the full meaning of the terms in which it is stated, and make the application to the illustrations. Do we not simply *assume* that they will *invent* a method of study for themselves? It was years before I myself realized that I had been making this assumption, and how woefully wide of the truth it was.

It is a platitude to say that no method of teaching which disregards fundamental properties of the human mind can possibly be successful. Yet I must confess that I have used for years precisely such methods without realizing the fact. For example, the lecture places the student in a *passive and receptive attitude.* Yet it is not the reception, but the reproduction of an idea that fixes it in our memory. The *hearing* of a story makes no permanent impression. It is only after we have retold the story that it suddenly leaps into a permanent position in our repertoire. The first hearing of an idea produces but a faint track in the brain. It is the putting together of this idea, in its original setting, and also along with new ideas, that converts the first faint track into a traveled road. Is it not one of the strong points of language study, that the student must put together, in an endless variety of forms, the limited number of ideas he is trying to master, and must do this by his own efforts?

Again, *repetition,* explicit and persistent, is absolutely essential to fair acquisition. The lack of this in science teaching has recently been emphasized by President Remsen. Yet much repetition in a lecture is out of the question. It becomes tedious and boresome. It is like having the same person introduced to us formally five or six times over. We are conscious of boredom the second time, irritation the third time, rage the fourth time, and thereafter settled hatred of introducer and introduced alike whenever we hear that person's name. Yet, if we had been furnished with an opportunity spontaneously to recognize the person the second time, we should have been pleased to meet him on that occasion, we should have greeted him as an acquaintance on the third occasion, and have felt the impulse of close friendship before long. We can not alter human nature. In the study of language we have an opportunity to meet and recognize the friends whose acquaintance we first make through the dictionary, and the subsequent encounters

follow the line of our natural instincts. If we fail to recognize one of our word-acquaintances, the request for a fresh introduction comes from our *own side.* Does not the more informal discussion of chemistry in the class-room furnish just the sort of opportunity we require for continual repetition without boredom? Is the almost limitless repetition of language study one bit more than is necessary? Can we then afford to do with any less amount of it in studying a science? Can we afford to turn into lectures any of the all too few hours available for exercises in repetition and interrelation?

Finally, the student in a lecture course must *follow successfully* or he is lost. The lecturer is not a phonograph. He can not be turned back, so as to repeat the exposition of the idea which has somehow missed one of its marks, or to reproduce the key word which the student has somehow failed to catch. Extraordinary variability in the speed with which different individuals apprehend the same thing is one of the most conspicuous qualities of a group of human minds. Naturally the *lecturer* must set his speed to suit the pace of the slowest members. When the work is conducted in such a way that home preparation can not be avoided, as it easily can be, and is, for most lectures, the variable factors are eliminated from the class room and relegated to the study. Each student takes whatever amount of time is necessary for mastering the assigned lesson. And the assemblage which presents itself to the instructor is therefore of more nearly uniform quality.

If we had attempted to devise some method which should run contrary to all the conditions for successful undergraduate instruction, we could hardly have invented a scheme which would be more certain to fail than that I am discussing.

The main point is that we learn only by our own efforts, and not by watching the efforts of others. Some one has said that the college is a "gymnasium where the faculties of men are exercised and developed, rather than a boarding house where the students are crammed with facts." We develop physical muscle by *exercise.* Is there any other way of developing mental fiber? Can we ever cause mental fiber *to develop* by dealing out ready-made ideas: it is a psychologically impossible process. Is any one under the illusion that the fifteen thousand spectators at a football game get any perceptible physical exercise out of watching the performance of the teams?

The college course is to teach the student to *solve problems.* Let us beware of a method of instruction in which the facts are found, not by the student, but by the professor; in which they are arranged and related, again by the professor; in which the conclusions are drawn, by the professor; and the conclusions are finally tested, not by the student, but by the instructor. If by this process we manage to hypnotize the student into thinking that he has acquired the ability himself to solve problems, there will be a rude awakening when the time comes for him to solve problems without assistance.

A METHOD FOR TEACHING CHEMISTRY

To be more concrete, it seems to me that the following are the conditions for the teaching of college chemistry:

First, the laboratory and class-room work must run parallel with one another throughout the year, and the same subjects must be treated simultaneously in both. When separation occurs, the total "yield" is reduced to an astonishing extent, and conversely.

Second, specific laboratory exercises must

be assigned for each week. Punctual performance of these exercises must be insisted upon. The laggards must begin each week with the work of that week, before making up any leeway. Enthusiasts who would go ahead, and finally reach a point where they are performing experiments five or six weeks before they are to be discussed in the class room, must be restrained by force.

Third, the subjects for the class-room discussion must be assigned *in advance*, either from the laboratory experiments, or from the text-book, or both, and due preparation must be insisted upon in every instance. To insure preparation, a question susceptible of very brief treatment, yet dealing with some significant point, may be set at the opening of the hour. After five to ten minutes, the answers are collected, and later they are read, marked and returned. Such questions may be set at any class meeting, and as often as is necessary to secure regular preparation. The subject of the question, being now uppermost in the minds of the student, forms the best starting point for the subsequent discussion. In this way, a section containing as many as fifty to eighty students may be handled.

If the chief instructor has not time to conduct the whole of the work, *this*, the discussion or recitation, is the part of it from which his presence can least be spared. Here is the opportunity to use the maximum of knowledge, alertness and resourcefulness. Here is the place where the student shows how far he has been able to put together ideas for himself. Here is the place for repetition and interweaving. Here is the place for final removal of all difficulties and for distilling from the subject the last drop of instruction that it can yield.

During these exercises the usual demonstration experiments are shown at appropriate points.

By this arrangement the student can not feel that the laboratory work is for the acquisition of mechanical skill, or for the belated illustration of something mentioned in a past lecture. He is made to feel that it is a necessary and valuable part of the preparation for the class-room work—which is conducted so that the method of converting laboratory experience into chemical knowledge is made plain. Problems turn up unsought. The pupils have acquired at least the routine knowledge in the laboratory and at home, and the solving of the problems is almost the only thing that remains to be done in the class room. The whole time of the instructor is therefore devoted to teaching problem-solving.

I am offering these suggestions merely for what they may be worth. I have no desire to dogmatize in regard to details. I merely submit the almost self-evident proposition that the lecture-method can never play any appreciable part in training people to solve problems for themselves. Laboratory work, if dissociated from class work, will never do it either. A system which exacts continuous and thorough home-study, both of the text-book and of the results of the laboratory work, and provides for the maximum amount of the most skilfully conducted discussion of the results that can be provided, stands a strong chance of awakening and bringing to a high state of perfection this, the most essential of all the elements in the mental equipment of a human being.

If the instructor feels, for any reason, that lectures must be given, then many of the most serious defects of the system may be remedied by assigning the subjects in advance for home study, and setting a written question as described above. The whole process consumes ten minutes, but the preparation it entails makes possible the covering of nearly *twice* as much ground in the remaining forty-five minutes. Much

of the merely descriptive matter can be omitted, and the shorter explanations suffice.

SUMMARY

To return to our thesis: the college can reconstitute itself an indispensable and successful factor in American life if it will devote itself, *and confine itself*, to pre-professional work—specific work in preparation for the learned professions and for business—and if it will devote itself, *and confine itself*, to turning out men and women able to solve problems. I think we must be ready to admit that, to do these things, the college requires, and should have, a more definite source for skilled teachers, and that the college must vastly improve the methods of instruction in many of its subjects. If we as chemists can devise a method for training teachers of chemistry and can improve the methods of teaching the science themselves, we shall not only have done a service to the science, but we shall have contributed our share towards the rehabilitation of the American college. Perhaps we can do more than our share, if we are right in feeling that chemistry, appropriately taught, can furnish quite exceptional training in the art of problem-solving. We can make our contribution doubly welcome and doubly valuable if we are willing to tackle the problem at once and resolutely by scientific methods, and to put our solution quickly into practise.

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University of Chicago

COLLEGE CHEMISTRY BEYOND THE ELEMENTARY COURSE[1]

Since the character of college chemistry beyond the elementary course is determined to a great extent by the nature of the introductory work, one is compelled in a discussion of this kind to make certain suppositions concerning the nature of an elementary course, and to proceed upon the basis of these assumptions.

Toward the close of the first year, by imperceptible gradations, the course in general inorganic chemistry is often allowed to flow into routine analysis. I can not help feeling that this is especially undesirable. The practise materially shortens the course in general chemistry, and takes for its own uses time which might be spent with greater profit in the study of many properties of the metals which are more varied in character than the limited number usually chosen by the analyst for the purposes of testing and identifying these same elements.

If the elementary course has given the student a somewhat thorough preparation in general inorganic chemistry—a full year with the usual number of hours of recitation, lecture and laboratory work—the college student comes to his second year with the following customary divisions of chemistry before him: Qualitative analysis, quantitative analysis, organic chemistry, physical chemistry.

It would lead me too far afield to consider all of the courses which follow the student's elementary training; so I have chosen to limit my remarks to those courses only which lie in these divisions immediately beyond the course in general chemistry.

Among these divisions, qualitative analysis in the majority of cases is the one which may most profitably be made the successor of the first year of chemistry, provided, of course, this subject is approached from the proper standpoint. I fear, however, that many of our colleges, even to-day, have not emancipated themselves from the old method of teaching this subject, but are

[1] A paper read before the Section of Education of the American Chemical Society at Detroit, July, 1909.

still employing a plan which, although almost universal not many years ago, is now obsolescent. I refer to the purely mechanical process in which great emphasis was placed upon the art of making tests and separations, while the teaching of sound chemistry was a matter of minor consideration.

Under this régime, instruction in the laboratory usually fell into a routine and complacent following of some outline of analysis carefully arranged with side margins and pages with indented leaves for ready reference. The group separations were accomplished by unswerving adherence to certain tabulated schemes which demanded a minimum of mental exertion, and afforded a striking example of a "principle of least work." It was no uncommon thing to require a student to analyze one hundred "liquid unknowns," one hundred "solid unknowns" and forty minerals arranged in a row. The desired end was reached if the student, at the request of an instructor, could make a correct report of the "acids" and "bases" which he had found in each unknown.

The text-book frequently contained page after page of those incomplete equations in which the right-hand member was to be supplied by the student. This was often done in a successful way by the precarious process of analogy; but in many cases there were several guesses equally plausible, and the student generally made his choice without any effort to find out the facts in the case. When I think of the vagueness of these equations, I am reminded of a question which, I have heard, was once proposed to a class in history at an examination. It read, "Who chased whom how many times around the walls of what?" The answer to this question was probably more certain to be correct than the answers to be expected in the case of the fragmentary equations of the kind I mention.

If by chance any recitations were attempted in connection with this ineffective course, they usually degenerated into mere droning of equations, sometimes in unison, like a chant. In other words, the essential rôle of the course consisted in an endeavor to master the details of the manipulative art, with the result that the science underlying it was sadly neglected to the great detriment of the student who usually knew less chemistry at the end of his course in qualitative analysis than he did at the beginning of it.

To my mind, a course in qualitative analysis first of all should be designed to teach advanced general chemistry; in the second place it should aim to teach the necessary manipulative skill, a knowledge of which, I confess, is of the utmost importance for success in chemistry. The golden threads of physical chemistry have so intertwined themselves in every fiber of the warp and woof of general inorganic chemistry, and have so illumined the problems of analytical chemistry at every turn that there is no longer any excuse for making the subject matter of qualitative analysis profitable to the student mainly in the direction of acquiring laboratory technique. Such a course should furnish the teacher a most fortunate opportunity for presenting to the student certain views of general chemistry in a manner more advanced and more forceful than the latter has ever met them before; and should serve at the same time as a means of relating and fixing facts which, up to that time, may have been unrelated and vague.

I have in mind a course of recitations with lectures, so arranged that points taken up in the class-room shall be illustrated again and again in the laboratory practise

through the solution of definite problems suggested by the analytical operations themselves. The lectures should be very largely experimental, and might consider, among other things, the logical sequence of the most essential facts which led to the proposal of the theory of solution; the experimental basis for the hypothesis of ions and the theory of electrolytic dissociation; the significance and application of the laws of chemical equilibrium (homogeneous and heterogeneous) with illustrations chosen from the wealth of material furnished by analytical processes.

As an outcome of the discussion of the nature of chemical equilibrium, the student will be in a position to consider certain topics—the methods of deriving dissociation constants may be presented briefly, and the value to the analyst of a knowledge of these constants may be dwelt upon at some length; the problem of the solubility product may properly take some time, since there will be little difficulty in making its value and application plain by selected experiments, many of which the student himself may perform in the laboratory; the study of complex ions and their stability constants will furnish abundance of material for experiment and discussion. These few main points may serve to suggest the changes so greatly to be desired in the teaching of this division of chemistry in the colleges.

It is here that the subject matter of elementary physical chemistry and analytical chemistry overlap, and the one takes from the other certain chapters which may be of practical service to it in the successful elucidation of its particular problems. By this overlapping, qualitative analysis has ceased to be governed largely by rule of thumb, and has passed into an organized and orderly subject with that real "scientific foundation" prophetically announced by Ostwald a number of years ago.

What I have said concerning qualitative analysis applies with equal force to quantitative analysis. It must be admitted that the laboratory art is exceedingly intricate and varied, and should be thoroughly learned. When, however, the student is permitted to devote his entire time to it, except for interruption by a single weekly recitation on problems, the loss to him is irreparable.

As regards elementary physical chemistry there is little to say, since there are very few colleges which give any definite course in this subject, unless a course in theoretical chemistry is made to serve this purpose also; but it is doubtful whether the courses given under this title deserve to be classed as physical chemistry in the present sense of the term. There can be no question as to the desirability of such a course as a part of the college curriculum; its appearance in certain college announcements gives us hope that others may follow.

The recent changes which I have mentioned in connection with the teaching of analytical chemistry have gradually found an entrance into the methods employed in some institutions, and may be looked upon as fairly established in many quarters. With the teaching of organic chemistry the case is different. I believe that this division of chemistry is in a transition stage with respect to the content and character of the subject matter presented in the elementary course.

It is generally conceded that qualitative analysis ought to be the course which should follow logically upon the heels of the elementary course. In fact, this practise has been in vogue for so many years, and has been advocated by so many famous teachers that it has come to be looked upon as a matter of necessity, rather than choice. This, however, is by no means the case. For many years, organic chemistry has formed rather a mature part of a stu-

dent's course, and, in its advanced phases, must do so still. But there has come to be an increasing need on the part of students for this division of chemistry as a prerequisite for certain professional and scientific courses to follow; this has made it almost a necessity to insert organic chemistry immediately after the elementary course.

This juxtaposition has made the teaching of elementary organic chemistry a more difficult problem than it was, and has placed the teacher of this subject in a somewhat unfortunate and unenviable position. Those of you who have taught this subject are very well aware that the student is in the habit of approaching the course in organic chemistry with misgivings; it is proverbially a hard task, and is tabooed as "no snap." It seems to me that organic chemists have themselves to blame for this attitude. Let me cite one or two instances which may serve to justify this claim.

In the first place, the methods which were in vogue at a time when organic chemistry formed a more advanced part of the college curriculum have not been modified sufficiently to adapt it to the student at an earlier stage in his career in chemistry. As an illustration of this kind of fault, let me mention the universal practise of prefacing the systematic study of the various classes of organic compounds by a very detailed description of the quantitative methods of organic analysis. Instead of this, a brief statement of the essential principles would suffice. Except in a general way, these longer directions, still in use, are rarely comprehended by a student who has not taken quantitative analysis, and at the very beginning, they tend to create discouragement and discontent which could be dispensed with by applying a little sound pedagogy. Such remnants of earlier times and methods have no more justification at this stage than a minute description of every precaution necessary in the quantitative estimation of manganese would have as an introduction to a discussion of the compounds of manganese in a course of general inorganic chemistry. Numerous instances of this atavism are to be found in the elementary text-books of organic chemistry; there is little reason to doubt that they occur in the lectures as well.

A second and graver difficulty lies in the fact that there has come to be a widening gap between the methods employed in approaching the subject matter of general inorganic chemistry and the methods which we must believe are still not far from universal in attacking the problems of organic chemistry in an elementary course. Thanks to the timely warning of physical chemistry, and the practical example furnished by a few text-books of general inorganic chemistry, we have made a grand stampede to return once more to the facts of our experience as a basis of procedure. We have endeavored here to strip off much of the speculative husk which has encased the subject with almost impenetrable firmness. In this desirable simplicity, we are content to call a stone, a stone, and to name a flower, a flower. In the teaching of inorganic chemistry, this movement has demanded the wholesale striking out of intricately constructed graphic formulæ which had no serious or certain justification in facts, and therefore explained nothing. As a result, the other extreme has now been reached, and scarcely any of the reactions and relations considered in an elementary course of inorganic chemistry are presented to the student in this symbolic garb.

On the other hand, the organic chemist, up to the present time, has had little or no success in presenting his subject from an

inductive standpoint. The old genius is too strong, and stands menacingly by while he writes. Several text-books have made a bold start with this object in view; but after a brief beginning of little promise, the argument rapidly assumes the old dogmatic form. Substances are said to be aldehydes "because they contain the aldehyde group"; or unsaturated, "because they possess double bonds." At every turn, the chemical and physical properties of compounds are attributed to them as a result of certain "constitutions" or "groupings of the atoms within the molecules." Rarely, if ever, is the veil lifted, and the student permitted to see that, as a matter of fact, precisely the reverse order is the one which should hold, and that it is the physical and chemical properties which determine the constitution. It is a matter of some surprise that we do not hear of compounds with good constitutions, and of others, in pathological conditions perhaps, with bad constitutions. After an explosion of nitroglycerin, it would seem to be quite in keeping to hear that the compound unfortunately had ruined its constitution.

Since this difference of method has grown up within these two divisions of chemistry, it has come to pass that students, thrust suddenly into the field of organic chemistry, find themselves lost in a maze of symbols, formulæ and nomenclature. Since the elementary inorganic course at present has abandoned the use of graphic formulæ almost altogether, the student does not receive any discipline of that part of his mind which, for want of a better name, may be called his formulæ-comprehending faculty, and, in consequence, is at a loss to find himself in this unexpected confusion. No assistance is furnished him by the elementary texts of organic chemistry, because these volumes still take it for granted that the student has practised atomic gymnastics of the kind in favor some thirty years ago.

It seems to me that the teaching of elementary organic chemistry must soon undergo a radical change, perhaps a revolution. I believe this advance is developing at the present time. Let us return to the basis of experimental facts and observations, and let us state our theoretical conclusions with these fully in the foreground of our thoughts. There is no difficulty in presenting to the student a set of facts determined by experiment; and there is no impossibility in bringing him to see how these facts may be expressed, in part at least, by properly chosen symbols in terms of certain hypotheses and theories. The modern text-book of organic chemistry remains to be written; it will view the subject from this point of vantage.

In his memorable address before the German Chemical Society on the occasion of the celebration in his honor, held in 1890, Kekulé gave the well-known account of the origin of the theory of the benzene ring, and at the close of this account said, "Let us learn to dream, and then perhaps we shall find the truth . . . but let us beware of publishing our dreams before they have been put to the proof of the waking understanding."

LAUDER WILLIAM JONES
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HOW CAN THE BUREAU OF EDUCATION HELP THE CITY SUPERINTENDENT OF SCHOOLS?

AMONG the questions which the Country Life Commission asked in its hearings in the several parts of the United States which it visited was: "In what way can government help in the work of public education?" The question generally evoked two types of answer. The one,

Government can do nothing; each community must work out its own educational salvation; we must wait for the people to act; they should have the kind of schools that they want, and they should be free to develop educationally as fast or as slowly as they may care to; the whole matter of education should be left to them.

The other type of answer was diametrically opposed to this. It ran:

Government can and must help in the work of education; the nation has done much, but what it has done is all too little compared with what should have been done in promoting school work. We are told—and it is an accepted dictum of American life—that the very existence of the nation depends upon the spread of education among its people. Yet works meet for such a faith have not been produced at Washington. The federal government has consigned its chief interest to the care of a bureau, and has accorded to the titular head of all the educational work of this great country the dignity of a bureau chief. The authority of the United States Commissioner is even less adequate, for in his last report we read: "The Bureau of Education is peculiarly dependent upon the cooperative spirit among the school officers of the country, for it can only ask for information, which is given voluntarily or not at all." The initiative of local communities, and of the states in some cases, acting as a whole, has produced a variety of educational means, method, plans, systems, institutions, results. The nation spends vast sums in them, but there is too little coordination of all this work, too little wise planning and expert counsel, to accomplish the results which should be accomplished. Government should help by creating an agency to coordinate, encourage, initiate and oversee the educational activity of the entire land. The next great step in the advancement of learning among the American people is to enlarge and safeguard its interests, by giving the Commissioner of Education the rank and the authority of a secretary in the President's cabinet.

There is something to be said for both these points of view—much more, we think, for the latter than for the former. The interests of education are momentous. Its activities are so chaotic that it must have a pilot to direct its course. Dr. Draper has shown conclusively that a federal educational plan is needed, in order that the national government may more efficiently administer the educational undertakings and responsibility which are now parcelled out among a number of government officers. He has called upon the nation to use the educational office which it has created, and not to neglect and belittle it, but rather to make of it an educational organization worthy of such a people. President Pritchett has called attention to the confusion and false pretense which rub elbows with the standard work of standard institutions in the field of the higher education, and has pointed to a work of standardizing and criticizing and evaluating college and university incorporation, instruction and degree-giving, which must be done by the national government, if it is to be done at all. The national university at Washington is a project which will not down. What is most needed to bring it into being is a national educational agency, with sufficient authority to pass upon the nation's need for such an institution, and adequately to plan for it in whatever form it is needed. Without some guiding authority to shape it, it is certain to be a many-headed compromise, born of committee deliberations, rather than the powerful head of the nation's educational work, which only a responsible authority can make it. In other countries, the interests of education and the fine arts are generally regarded as so completely indivisible that they are committed to the care of a single minister of public instruction and the fine arts. So should it be here, and the same unity of interest should be recognized by educational and artistic forces everywhere throughout the land.

In addition to the administration of the educational work, which is already under the care of the nation, the standardizing and inspecting of the higher instruction of the country, the propagating of a national university in whatever form may be determined as most desirable, and the fostering of the fine arts as a function of government, there remains for the Secretary of Public Instruction and Fine Arts the work of maintaining a national clearing house to further the activities of primary and secondary education throughout the land. Like the Department of Agriculture, it should be a center for the com-

parative study of school work, and a distributing point of scientific knowledge upon every phase of education. It should be a consulting bureau. Like the Department of Labor, it would assist whenever needed. Strict uniformity of educational practise is certainly far from desirable, but greater uniformity than now obtains would just as certainly be for the best interest of all concerned. The department would be a center of inspiration and leadership for all who are concerned in the educational development of our nation. Besides, its expert help and its expert advice should constantly be available whenever and wherever needed. It should do the work of educational investigation and reporting which the Country Life Commission is now doing in regard to the sufficiency of the rural schools. It should plan for their improvement, and should be largely directive in shaping the educational features of such a far-reaching measure as the Davis bill.

As John Stuart Mill pointed out, experimentation, generalization and the formulation of laws for human guidance in the social realm are much more difficult than in the sphere of physical nature; for in social experimenting, the conditions can not be reproduced at will, and the laboratory, which furnishes the facts upon which the inductions of the moral sciences must be based, is the world. Correspondingly urgent is the need for special provision for furnishing such assistance and guidance as a thoroughly furnished central agency of the national government could give to its large and continuing educational activities. That there is here a specific field for governmental activity, the organization of other governments sufficiently proves. The fear of over-centralization through such a department is but a nominal objection to its existence. Agriculture is not centralized or nationalized by being promoted and encouraged by a Secretary of Agriculture. Neither is commerce. But agriculture has profited enormously through the assistance of the department at Washington. Education should profit in the same way. Political control would not interrupt the work of such a department more than it interrupts the work of the other departments of the national government. Indeed, the national government, through its civil-service standards, and its civil-service propaganda, should be able to lend very material assistance in taking the schools out of politics, and in substituting civil-service methods of appointing teachers for the political give and take which, but for assistance from without, bids fair to dominate public school work for some generations to come.

In reply, therefore, to the question, How may the work of the Bureau of Education be expanded so as to aid the city superintendent in his work? I would answer, first, by greatly increasing the power and authority of the office, by promoting the Commissioner of Education to the highest possible position of leadership which the nation can create, and thus giving to school officers of every grade the fullest aid and encouragement which the national government by its example as well as by the thoroughly expert assistance at its command, can render. Not only will the educational arm of the public service be dignified, the esprit de corps of the teaching profession itself will be improved by taking on something of the strength of organization which it has under the governments of the old world. A city superintendent of schools in any one of the larger cities of America is frequently forced to fight an unequal battle against the conditions that war for the undoing of education, simply because there is as yet no sufficient professional support in the land for the educational ideas which he is called upon to defend. No voluntary organization of teachers, no unofficial propaganda for education, no official assistance which a state government is able to render, can have the strength and effectiveness which the national government can command in promoting and intensifying the educational sentiment of the country. The city school systems are called upon to lead in educational invention and readjustment and reorganization of work. Of consulting agencies whose aid they may invoke there are practically none save the officials of other school

systems, whose eyes are usually turned inward upon their own work, and university departments, whose knowledge of ways and means is by no means complete. The educational office at Washington can be of the greatest service by continuing to do what it is already doing so well, viz., to publish carefully prepared bulletins upon current educational problems. Its recent bulletin upon the apprenticeship system in the United States furnishes a preliminary survey of the field which had to be made before plans for industrial training could be made with knowledge and with certainty. But there are 10,000 questions which school officers will want to ask, and not a few expert opinions which will be required, and some special studies even which they will want made before instruction along industrial lines can be reduced to school terms, and properly launched as a subject of study. There are a myriad of points upon which expert opinions are wanted, such as one may get in medicine or in law, when in need of them, but which education has not as yet formulated a definitely satisfactory means of supplying. For illustration, Should education and school management be a matter of state supervision and control, or should they be left to the care of the community alone? This is the old question of a state system *versus* local organization of schools, but it is not a moot question, for school systems are being reorganized daily, and it must be that experience and use have shown that these plans are not equally advantageous. Again, what is the proper relation of a city school system to the municipal government of the same territory? The court of appeals of New York State has declared that it is "the settled policy of the state, from an early date, to divorce the business of public education from all other municipal interests or business." Can public education endure unless it maintains this independence of purpose, function and control? And yet the rapidly-growing cities of the country are allowing their school departments to be annexed to the city hall so completely and so rapidly that freedom to do an educational work bids fair to disappear in many parts of the country. Shall the city board of education fix the amount of money required for school purposes each year, or shall the most corrupt and most inefficient of American institutions, the city government, do it? It makes a vast difference in the effectiveness of a school department how this question is answered, though the total tax rate may remain the same. School departments now segregate their expenses and statistics in one way for the commissioner at Washington, in another for the state superintendent; and sometimes in a third for the city authorities. The Commissioner of Education is attempting to reduce this chaos to order by securing the adoption of standard forms of school reports; but this necessary reform is greatly hindered by the fact that the acceptance and use of such standard forms must be a purely voluntary matter, as the commissioner can not require it. The Bureau of Education could be of very great service by standardizing the different kinds of charges which should be regarded as legitimate claims against the various school funds. As, for instance, What items are proper charges against a public school building fund, and what must be charged to contingent funds? Is new furniture put into an old building to be charged to one, or the other? How about the remodeling of buildings to make escape from them easier in case of fire? Must this be classed as repair work, or as building? Neither the laws nor the decisions of the various states are quite specific upon such points. The need for uniformity of practise is not so much that the proper charges may be made, but that, having been made, caviling critics may not be able successfully to attack them. There is a national municipal system of bookkeeping which unofficially is doing for cities what a similar system worked out by the Bureau of Education should do for the accounting of the schools. What are the health measures which a city school system should undertake? How can it best proceed to enforce the compulsory education law, and bring all its children into school? What responsibility should it assume for the child-labor law? How can it assist in preventing juvenile delinquency? What part

can it take in the work of promoting the general welfare of children? Besides there are ever with us the great questions of the course of study and methods of learning—the what and the how of teaching. In collecting and reporting the more successful experiments which are being made in the schools of any part of the world, the Bureau of Education is doing an incalculable service in making well-established scientific formulations of education possible. Special help is needed in the study of ways and means for the teaching of morality and the elements of law that no child may grow up without being well grounded in the knowledge of the fundamental relations of human beings. The office of the Commissioner of Education has always been wisely and ably administered. It has been of immense assistance in promoting education in the United States. It is reaching out to a larger work. The time is ripe for it. But to do it, the Bureau of Education must have larger appropriations, more experts, and above all, a much larger authority and function in the service of the nation.

E. C. Moore

Los Angeles, Cal.

WATER VAPOR IN THE ATMOSPHERE OF THE PLANET MARS[1]

An expedition from the Lick Observatory, University of California, was recently sent to the summit of Mt. Whitney, the highest point of land in the United States, through the private generosity of Regent Wm. H. Crocker. It had for its purpose to study the question of water vapor in the atmosphere of the planet Mars. The instruments consisted of a sixteen-inch horizontal reflecting telescope and a suitable spectroscope. The observations, made on the nights of September 1 and 2, were mainly photographic.

Water vapor in the atmosphere of any planet causes dark bands to be formed at certain definite positions in the spectrum of that planet; conspicuous bands if the water vapor is abundant; inconspicuous bands if the quantity is slight, as this, the only method known, is not a sensitive one.

The observer of Mars must look up through the earth's atmosphere; and the great quantity of water vapor in our atmosphere, if the observer is near sea level or at ordinary altitudes, blots out the effect of any Martian vapor, making a solution of the problem impossible. By ascending Mt. Whitney, altitude 14,501 feet, the Crocker expedition placed itself above probably four fifths or more of the earth's water vapor. Further, the air on Mt. Whitney was astonishingly dry during the time of the observations. With barometer $17\frac{3}{8}$ inches, air temperature 29 degrees Fahrenheit, and wet thermometer 17 degrees, students of the atmosphere will recognize that the observers of Mars were looking through remarkably little terrestrial water vapor. Even this small quantity would be almost fatal to success if we did not have a fairly satisfactory method of eliminating its effects, as follows: Our moon has no appreciable atmosphere. The lunar and Martian spectra will be affected alike by the water vapor in the earth's atmosphere. These spectra are photographed, one immediately after the other while the conditions in our atmosphere remain unchanged, and with the moon and Mars at the same altitude above the horizon so that their rays traverse equal paths in our atmosphere. If the vapor bands in the Martian spectrum are found to be stronger than in the lunar spectrum, Mars has water vapor in considerable quantities. If the bands in the two spectra are equally strong, water vapor on Mars does not exist in sufficient quantities to be detected by the spectroscopic method. The latter condition was found to exist, when this method was applied under the superlatively favorable conditions existing on Mt. Whitney. Both spectra were photographed when Mars and the moon were near the horizon, again when they were at medium altitudes, and finally when they were 49 degrees above the horizon. The best vapor band, technically called "a," was faint in both spectra when the bodies were low, fainter when the bodies were higher, and very faint when the bodies were at their highest; but for equal altitudes the "a" bands in the Martian and

[1] Statement by Director W. W. Campbell, of the Lick Observatory, prepared for the Associated Press.

lunar spectra were equally intense; plainly signifying that the observed bands were due to water vapor in the earth's atmosphere above the summit of Mt. Whitney. This does not mean that Mars has no water vapor, but only that the quantity present, if any, must be very slight. Let us recall that we see Mars by reflected sunlight. The rays which reached our instruments passed from the sun into the Martian atmosphere, for the most part down to the surface of the planet, and then out again to us, thus passing twice through the planet's atmosphere and any water vapor it may contain. Even with this multiplying effect on Mars the vapor bands in the Martian and lunar spectra were alike, and we conclude that any water vapor in the Martian atmosphere must have been much less extensive than was contained in the rarefied and remarkably dry air strata above Mt. Whitney.

These observations do not prove that life does not or can not exist on Mars. The question of life under these conditions is the biologist's problem rather than the astronomer's.

SCIENTIFIC NOTES AND NEWS

Dr. Ira Remsen, president of the National Academy of Sciences, has consented, at the request of Dr. H. F. Osborn, president of the American Museum of Natural History and Mr. Archer Huntington, president of the American Geographical Society, to appoint a scientific commission to examine the records of Lieutenant Peary and Dr. Cook, in case they are ready to present them to such a commission. Lieutenant Peary has accepted the suggestion, and it is reported that Dr. Cook will under certain conditions also accept.

The mayor of Baltimore has nominated Dr. William H. Welch, of the Johns Hopkins Medical School, as a member of the new charter commission.

The University of Manchester has conferred an honorary doctorate on Dr. Otto Wallach, professor of organic chemistry in the University of Gothenberg.

An international committee has been formed to celebrate the fortieth year of university work of Professor Henrico H. Giglioni, professor of zoology at Florence.

Mr. R. Priestley, who left University College, Bristol, to join Mr. Shackleton's Antarctic expedition as geologist, has left England for Australia on October 22. He intends to join Professor Edgeworth David, F.R.S., at Sydney University, to work up the geological results of the expedition.

We learn from *The Journal of Terrestrial Magnetism* that the Norwegian Storthing has voted to Professor Birkeland 5,000 kroners annually for four years, making a total of 20,000 kroners (about 5,300 dollars), thus enabling him to continue the publication of his investigations on magnetic storms and polar lights.

Professor Charles Josiah Smith, of the chair of mathematics of Western Reserve University, has been given leave of absence for the year.

Dr. Charles H. Mayo, of Rochester, Minn., will deliver two lectures at the University of Maryland, on November 9 and 10, on "Diseases of the Thyroid Gland," and on academic day he will receive from the university the honorary doctorate of laws.

On the opening of the graduate school of the University of Pennsylvania, on September 30, Dr. Thomas H. Montgomery made an address on "The Making of the Investigator."

Mr. John Birkinbine, president of the Pennsylvania Forestry Association, will give a lecture at Lehigh University during the present month on "The Relation of the Engineering Profession to Forest Preservation." This lecture and others have been made possible by a special gift for increasing interest in forestry.

The valuable scientific library of the late Professor Simon Newcomb has been purchased by Mr. John Claflin for the College of the City of New York.

The death is announced of Dr. Anton Dohrn, founder and director of the Biological Station at Naples, and eminent for his contributions to zoology.

Dr. Max Heinze, professor of philosophy at the University of Leipzig, known for his important publications on the history of philos-

ophy, died on September 17, at the age of seventy-three years.

Mr. Bryan Cookson, assistant at the Cambridge Observatory, has died at the age of thirty-six years.

A bronze tablet, three by two feet, has been installed in the building of the New York Aquarium, it being the New York Zoological Society's contribution to the Hudson-Fulton Celebration. The tablet is inscribed:

This building first known as West Battery, erected 1807–1811—Called Castle Clinton after the war of 1812—Ceded by Congress to New York City 1823—Subsequently known as Castle Garden—General Lafayette received here 1824, President Jackson 1832, Kossuth 1851, the Prince of Wales 1860—Jenny Lind first sang here 1850—The landing place of eight million immigrants, 1855–1890—Connected with the land by a bridge prior to 1869—Converted into an Aquarium 1896—Placed under control of New York Zoological Society 1902—Aquarium visitors twenty-one million to 1909.

The last legislature of North Dakota passed a comprehensive pure seed law intended to regulate the sale of agricultural and garden seeds, providing for proper labeling of such seeds, and for the establishment of a Seed Control Laboratory at the North Dakota Agricultural College, in connection with the department of botany. Dean H. L. Bolley was made state seed commissioner and Mr. Orin A. Stevens, of the Agricultural College of Kansas, was elected assistant in charge of the laboratory. The laboratory is well equipped for all types of seed investigation and opened for work on October 1.

At a meeting of the board of directors of the American Chemical Society held at the Chemists' Club, New York, on September 13, it was voted that an additional amount not to exceed seven hundred dollars be appropriated for the purposes of the *Journal of Industrial and Engineering Chemistry* for the balance of the fiscal year provided that no issue of the journal to which this appropriation is to apply shall exceed sixty-four pages exclusive of advertisements and cover. The amount of material offered for publication having become so great, it was voted that the directors recommend that the editors of both journals should not feel obliged to print all matter that passes their respective boards, but should conduct their journals from the standpoint of those who read rather than from that of those who write, making a selection of those articles which, having passed their boards, are in their opinion of the greatest value to chemical science and industry.

The London *Times* states that a group of French, German and Belgian patrons of aviation are offering a prize of 250,000 f. (£10,000) to be awarded to the aviator who rises, with a fixed point as center, to a height of 250 meters, flies a thousand meters from this altitude in a horizontal direction, and finally, returning, soars for a quarter of an hour at a height of 20 meters over the point of departure. An alternative feat is to make a flight from Brussels to Paris or from Brussels to Cologne, without a stop, at a speed of 60 kilometers an hour. At Spa the final preparations for the competition have now been made, and MM. Paulhan, Sommer, Druet, Delagrange and Le Blond have their machines ready in their sheds for the trials.

The New York *Evening Post* states that Dr. Paul Vouger, of the Museum of Neuchatel, Switzerland, has given the archeological branch of Peabody Museum, of Yale University, two cases of prehistoric implements in stone, iron, horn and bronze. A collection of Indian antiquities has been received from G. W. Rittenour, '09. By an exchange there has been received from Stockholm, Sweden, an ethnographical collection made among the African tribes of the Congo. From the Egyptian exploration fund has come a collection from the tombs at Mahaska and Abydos. It includes articles in ivory, vases, beads, ornaments, palettes and pottery.

In the Public Health Reports for August 27, 1909, appears an article on "Plague among Ground Squirrels in Contra Costa County, California." In 1894 plague began to spread from central Asia. Since then it has been carried to practically all parts of the world, including the Pacific Coast of the United States, where the disease has appeared in man,

in rats and in ground squirrels. The infection in ground squirrels has so far appeared in Contra Costa and Alameda Counties, California, chiefly the former, where, up to September 10, 1909, 220 plague-infected squirrels had been found. The Public Health and Marine-Hospital Service is attempting to destroy all the ground squirrels in the involved area, or at least to so reduce them in number that the plague infection among them will die out of its own accord. This article gives a detailed account of plague infection among the ground squirrels in Contra Costa County, and the relation of squirrel plague to plague in man. It also describes the means employed for the destruction of the squirrels, and gives a serial list of infected squirrels with the location where found. The article has been reprinted, and a limited edition is available for distribution to those interested. Requests for copies should be made to the Surgeon-General, Public Health and Marine-Hospital Service, Washington, D. C.

A bill to promote the economic development of the United Kingdom and the improvement of the roads was introduced in the House of Commons on August 26 by the chancellor of the exchequer. In the explanatory memorandum, as summarized in *Nature*, it is stated that the bill enables the treasury to make free grants and loans for the purpose of aiding and developing forestry, agriculture and rural industries, the reclamation and drainage of land, the improvement of rural transport (other than roads), the construction and improvement of harbors and canals, and the development and improvement of fisheries, and for many other purposes calculated to promote the economic development of the United Kingdom. A grant or loan must be made either to or through a government department, and all applications for grants or loans have to be referred to an advisory committee, and the recommendations of the committee considered before the grant or loan is made; but the responsibility of making the grant or loan will rest with the treasury, who will not be bound by the recommendations of the committee. All grants and loans will be made out of a separate fund, which will be fed by (1) sums annually voted by parliament; (2) a sum of £2,500,000 charged on the consolidated fund and payable in five annual instalments of £500,000 each in 1911, 1912, 1913, 1914 and 1915; (3) sums received by way of interest on and repayment of loans and the profits made as the result of a grant or loan in cases where the repayment of such profits is made a condition of the grant or loan. Power is given to the Board of Agriculture and Fisheries and the Department of Agriculture and Technical Instruction for Ireland to acquire land (compulsory if necessary) for any purpose for which a grant is made to them. The bill will permit the expenditure of money on scientific research and experimental work of a kind likely to be beneficial to agriculture. The bill further constitutes a Road Board for the purpose of improving the facilities for motor traffic. In addition to the power of acquiring land for the purposes of new roads proposed to be constructed by the Road Board, the board is given power to acquire land in rural districts on either side of any such proposed road to the extent of 220 yards in depth.

UNIVERSITY AND EDUCATIONAL NEWS

Harvard University has received $15,000 from Mrs. James Augustus Rumrill, to establish three scholarships.

The alumni fund of Yale University was increased last year by $73,000, the total fund now being $361,000.

An anonymous gift of $250,000 has been made toward providing a pension fund for teachers in the public schools of Pittsburgh.

Ex-governor James D. Porter, LL.D., has resigned the presidency of Peabody College for Teachers at Nashville, Tennessee, which office he has held for seven years. The duties of the office have been assigned to Dr. J. I. D. Hinds, professor of chemistry, and for several years dean of the college faculty. Dr. Hinds will hold this position until a president is elected by the trustees of the New George Peabody College for Teachers, which is now in the process of organization. Governor Por-

ter retains his position as a member of the Peabody Education Board and chancellor of the University of Nashville.

Major Frederick S. Russell, U.S.A., professor of pathology in the Army Medical School and curator of the Army Medical Museum, has been selected to succeed Dr. Joseph J. Kinyoun as professor of pathology and bacteriology in George Washington University.

Dr. Ross Anderson has resigned as professor of bacteriology and pathology in the University of Utah, and has been succeeded by Dr. Frank A. McC. Jenkin, of the University of Michigan.

At Western Reserve University, instructors have been appointed as follows: John A. Black, A.M., in chemistry; A. H. Ford, A.M., in mathematics; Clinton R. Stauffer, in geology; Davidson Black, M.D., in histology and embryology.

In the medical department of the University of Texas, Dr. Henry Hartman has been appointed demonstrator of pathology and Dr. E. E. Calloway, demonstrator of anatomy.

E. H. Henderson, Ph.D. (Columbia), professor of education and psychology at Adelphi College, Brooklyn, has been transferred to the chair of philosophy.

Dr. S. E. Wolbach has been appointed director of the histological laboratory of McGill University.

At Queen's University, at Kingston, Ont., Dr. W. O. Walker has been appointed associate professor.

Dr. George A. Gibson, F.R.S., has been appointed professor of mathematics at Glasgow, in succession to Professor Jack, who has resigned.

Mr. T. Mather, F.R.S., has been appointed professor of electrical engineering at the City and Guilds Central Technical College in succession to the late Professor Aryton, F.R.S.

Mr. William Brown, B.Sc., lecturer in electro-technology at the Royal College of Science for Ireland, has been appointed, as from October 1, to the chair of physics in the college, which will become vacant on that date owing to the retirement of Professor W. F. Barrett, F.R.S., under the treasury regulations as to age.

DISCUSSION AND CORRESPONDENCE

PROGRESS OF THE INTERNATIONAL LANGUAGE ESPERANTO

On account of the importance of an international language to science, American scientists will undoubtedly be interested in the following bits of information concerning the international language Esperanto. This language was endorsed by the Pan-American Scientific Congress, which met in Chili, and it was recommended that Esperanto be taught generally in the schools.

The International Medical Congress, which met this summer at Buda Pesth, received ten reports in Esperanto.

The International Congress of Psychologists, at its recent meeting in Geneva, admitted Esperanto as an official language, placing it on the same basis as German, French, English and Italian. Four addresses were made in Esperanto at the general sessions.

The report of the ninth International Congress of Geography, recently held in Geneva, has been printed (unofficially) in Esperanto.

The eighth International Congress of Hydrology, Climatology and Physiotherapy, which met in the city of Algiers in April, made official use of Esperanto in its sessions.

The Brazilian government recently published in Esperanto a résumé of the industrial development of Brazil. As any one who is familiar with one or two modern languages and knows a little Latin can easily acquire a reading knowledge of Esperanto in a few weeks, it is suggested that any who are interested in the above report might do well to secure a copy of it. Many other minor notes might be given, showing that Esperanto is rapidly assuming the place which was intended for it, namely, as a means of inter-communication between people who speak different languages.

I may add to the above notes that there is a strong international organization of physi-

cians, of which Esperanto is the official language. Their journal for May consisted of 24 pages devoted to important medical subjects. Thus far, physicians have made more use of Esperanto than any other profession. They realize the importance to medical science of an easy means of communication between men of the profession all over the world and are rapidly coming to make use of Esperanto for this purpose.

Some of the large type foundries of Europe are now prepared to furnish the few special letters required in printing Esperanto, in various styles.

Five international congresses for Esperanto have been held, between thirty-five and forty nations being represented either officially or unofficially in the last three. The sixth international congress for Esperanto will be held in Washington, D. C., in August, 1910.

A strong organization exists in Europe, with headquarters at Geneva, for the production of technical vocabularies for Esperanto. The writer has been requested to act as secretary for this organization for the United States. He would be glad to communicate with scientists in all parts of the country who may be interested in this work. It will only be a few years until technical vocabularies will be available, so that all important results of investigations can be printed in Esperanto, and thus become available to the whole world.

The fact that there are eighty-six periodicals published in Esperanto, eight of which are published in the United States, may be taken as an index of the growth of the movement for an international language, a movement which now seems assured. Having taken the trouble to learn the language I wish to assure those who are interested that the amount of labor involved in learning Esperanto is certainly not more than one fiftieth that required to learn German.

W. J. Spillman

U. S. Department of Agriculture

GEOLOGY AND COSMOGONY

To the Editor of Science: 1. In reply to Professor Barrell's communication in your issue of July 2, 1909, it is sufficient to say that he carefully passes over the legitimate question under discussion, which is that the mountains are formed by the sea, and not at all by the shrinkage of the earth, as taught in most of the books on geology. Since he has thus evaded the issue, his long-drawn-out discussion requires no further notice.

2. In reply to Moulton's statement in your issue of July 23, let me say that my work on the spiral nebulæ and on the formation of the solar system, under the secular action of a resisting medium, was essentially completed July 14, 1908, and my subsequent application for copies of his papers (received here in October, 1908) was simply to enable me to make exact references in some of the arguments refuting his theories. This is well known here, for I was all the while in frequent consultation with members of the astronomical and mathematical faculty at Berkeley, and they were fully informed of the results at which I had arrived. My results were held back for over six months (cf. *A. N.*, 4308), and so new did the conclusions appear to the astronomers of the Pacific coast that when my paper was given to the Astronomical Society of the Pacific, January 30, 1909, several of them stated in public interviews in the San Francisco papers that they were exactly the opposite of previous theories.

3. In the *Astrophysical Journal* for October, 1905, Moulton develops a theory that spiral nebulæ are formed by one star passing by another, and causing spiral ejections of prominences under tidal forces. This idea seems to have originated with Chamberlin, as outlined in his paper on the "Function of Disruptive Approach, etc."[1] Here are some of the arguments against these Chamberlin-Moulton theories: If such tidal disruptions were in progress, spiral nebulæ would be prevalent in the Milky Way, and above all in globular clusters; such is not the case. Perrine has recently shown, in Lick Observatory Bulletin No. 155, that the globular clusters are quite devoid of nebulosity of any kind. Lastly, if spiral nebulæ are due to the disruption of one star by another, then both stars would usually be disrupted in passage, and spiral nebulæ should

[1] *Astrophys. Jour.*, 14, 17–40, 1901.

thus occur in pairs, which is not a fact. This theory of spiral nebulæ is therefore directly contradicted by the most obvious phenomena of the heavens.

4. In the same number of the *Astrophysical Journal* it is announced that Saturn's ninth satellite, *Phœbe,* can not now escape from the control of the planet, so, "conversely, it has never come under Saturn's control from a remote distance." Of course this interpretation of the use of Jacobi's integral is wholly unjustifiable. Under the secular action of a resisting medium such a capture is perfectly possible, and it has actually taken place, not only for the retrograde satellites, but for all of them.

5. The planets and satellites could have been formed in but one or more of the three following possible ways, and in no others whatsoever: (*a*) Detached from their central masses by acceleration of rotation, as imagined by Laplace. (*b*) Captured from the outer parts of a nebula devoid of hydrostatic pressure and thus added on from without, as announced by the writer in *A. N.*, 4308. (*c*) Formed right where they now revolve by the agglomeration of cosmical dust.

Now the possibility (*a*) is forever excluded by what I have called Babinet's criterion (*A. N.*, 4308); while (*c*) will not be seriously considered by any one of ordinary understanding. This leaves (*b*) as the only possible mode of formation.

6. Not content, however, with proving by the logical process of exclusion that the planets and satellites were captured, I have since developed a rigorous proof, based on a correct interpretation of Jacobi's integral under the physical conditions existing in actual nature, of just how the capture of satellites comes about. A series of papers on this subject is just now appearing in the *Astronomische Nachrichten,* No. 4341–42, 4343, etc.

7. It is thus proved that the planets were captured by the sun and have gradually neared that central mass under the secular action of a resisting medium. This cause and no other has given the orbits their round form. It is proved also that the satellites likewise were captured by their several planets. If Moulton and Chamberlin have reached any but negative results, I have not yet seen them, and I shall look forward with interest to their publication. Since naturally a thing has occurred in but one way, it is evident that there are in general an infinite number of ways in which *it did not occur.* Such negative results may be as numerous as the sands of the sea, or as the points in space; but they will no more nourish our minds than empty space will feed our bodies. I submit that protest against such vacant results is certainly justifiable.

T. J. J. See

U. S. Naval Observatory,
Mare Island, California,
August 2, 1909

"UM" AND "IUM" ENDINGS

The Editor of Science: A subject which has interested me for some time is the existing lack of uniformity in the ending of the names of some chemical elements. In view of the fact that nomenclature is under discussion at the present time, possibly some remarks on the above subject may not seem presumptuous.

Some of my spare moments have been employed in trying to find if there were any conclusive reasons why five of the elements should have the endings they possess rather than endings in conformity with the majority of their brothers in the list of elements. The five I refer to are glucinum, lanthanum, molybdenum, platinum and tantalum.

Using Roscoe and Schorlemmer as authority, the number of "um" and "ium" elements is forty-seven. Five of these (the above mentioned) have "i" absent in the ending. Of the latter the Oxford English Dictionary and the Century Dictionary are authorities for spelling glucinum, lanthanum, tantalum both with and without the "i." Therefore there remain but two of the elements which as far as I have been able to discover are never spelled with the "ium" ending. In fact the leading text-books on chemistry and writers on scientific subjects spell all five elements with the "um" ending. So we are justified in believing it to be common usage to leave out the "i" in the spelling of the five elements under consideration.

Yet on the other hand there seems no really good reason (other than common practise, which is recognizedly potent) for discarding the "i." I have somewhat hurriedly scanned the works of Skeat, on etymology, in search of some authority, besides that of the elements' discoverers, for the prevailing spelling. I have been unsuccessful. Some time ago I was told by an eminent philologist that the formation of modern Latin words does not always follow fixed rules. Also, an eminent Boston chemist informed me that outside of the dictionaries he knew of no authority for the present spelling of the elements under discussion. It is evident that in the beginning the authoritative spelling of the name of any element is due to its discoverer in almost all cases. For when we read of the discovery of an element and learn that its discoverer gave it a name in conformity with the names of existing elements (provided it is an "ium" element) we observe that there is a tendency toward the species of uniformity which is the subject of this note.

If we take all the "ium" and "um" elements and consider them from the standpoint of—what I may call—syllabic uniformity, we see that there are twenty-six elements of three syllables; seventeen of four; three of five, and one of six. Platinum falls into the first class, and molybdenum into the second, which two classes compose the great majority. If we add "i" to the endings of these elements, then platinum still remains in the majority class and molybdenum passes into the minority. Can it be possible that the naming of the elements with a design for syllabic uniformity had a place in the minds of the various discoverers? It would seem fair to assume that such was not the case. Therefore a possible argument in favor of the present spelling of the two above mentioned elements is eliminated.

On the other hand, the argument in favor of what may be called terminal uniformity has more to recommend it than syllabic uniformity. Aside from the very desirable property of terminal uniformity itself, the sound of the pronounced word ending in "ium" is more pleasing to the ear, and its appearance is more pleasing to the eye, than is the word with the "um" ending, which gives the sensation of dullness, and is dumpy. While by simply adding "i" the pronunciation of the word "platinium" for instance, becomes at once musical. Any one uttering the word first with one ending and then with the other will appreciate the last remark.

In conclusion, one may say that although the "um" elements have back of them the power of common usage (as did aluminum some years ago—now we almost invariably write aluminium) yet there seems to exist an unnecessary lack of harmony in the spelling of some elements. However, this discord is not at all extensive, for according to the highest authorities the only elements at present irregular are platinum and molybdenum. It is only a few years ago that it was very common to write "aluminum," now it is rarely used by scientific writers. This change has been brought about by their adoption of the more approved spelling. Why may not the contemporary scientific writers go a step farther, and whenever they find it necessary to use the names of these elements, write them glucinium, lanthanium (lantanium), molybdenium, platinium and tantalium? Should the many influential scientific men find the suggestion here offered pleasing to them and furthermore worthy of adoption, then, in a short time, there would be introduced into the spelling of the names of elements a greater uniformity than at present exists. G. B. O.

Providence,
July 5

SCIENTIFIC BOOKS

Mendel's Principles of Heredity. By W. Bateson. 396 pp., 6 colored plates, 3 portraits of Mendel and 35 figures in the text. Cambridge (England) University Press; also New York, G. P. Putnam's Sons. 1909.

This is not a new edition of the book published under the same title in 1902 by the same author and publisher, but for some time now out of print. That little book served a useful purpose in directing the attention of

biologists to the newly rediscovered discoveries of Mendel, but at the present time a book with a wider scope is needed and it has been supplied by the author.

The present work omits the controversial features of its predecessor, which happily are no longer required, but adds in Part II. some interesting biographical material and three portraits to the translation of Mendel's original papers which the earlier book contained, and gives a comprehensive account of the development of Mendelian principles of heredity down to the present year. It may be regarded as an authoritative statement of Mendelism at the present time. No small part of the book is taken up with an account of the author's own investigations, which have probably added more to our present knowledge of heredity than has come from any other source since Mendel's time.

Chapter I. contains a brief account of pre-Mendelian writings on heredity, of the rediscovery of Mendel's law, and of the essential feature of that law, "segregation."

Chapter II. contains a list of observed cases of Mendelian inheritance, with the name of the observer in each case and bibliographic references to his work, and a statement of its most important features. The fact is emphasized that in animals and in plants, and both among domesticated and among wild forms, the laws of heredity are the same. The nature of "dominance" and the occurrence of distinctive heterozygous characters are topics also considered here. Regarding dominance, the conclusion is reached that "a dominant character is the condition due to the *presence* of a definite factor, while the corresponding recessive owes its condition to the *absence* of the same factor."

A critical comparison is instituted between the Mendelian system and Galton's system of analyzing the facts of inheritance, and the inadequacy of Galton's system is shown. Praise is bestowed upon Galton for his early attempts to break a path through the unexplored fields of heredity, but his followers are censured for persistently closing their eyes to the fact that Mendel has opened a path.

In a third chapter explanation is made of the usual Mendelian "ratios," 3:1, 9:3:3:1, etc., and an account is given of how novelties may arise, by recombination of the separate factors of compound characters. Examples from breeding-experiments with fowls, primroses and sweet-peas serve as illustrations.

The next five chapters, about a fourth part of the book, deal with color-inheritance in plants and animals. This is no undue amount of attention, since the phenomena here dealt with are the most carefully studied and the most instructive of all Mendelian cases.

In this part of the book are discussed and illustrated the modified Mendelian ratio 9:3:4, the "presence and absence hypothesis," epistatic and hypostatic factors, reversion on crossing, and a variety of related topics of greater or less complexity.

A chapter on "genetic coupling and spurious allelomorphism" precedes and leads naturally to a discussion of "heredity and sex." The theory is here advocated that sex has its ontogenetic origin in gametic differentiation, that in each species of animal or plant one sex is heterozygous, the other homozygous as regards the differential sex-factor. In the cases studied by experimental breeding methods the author concludes that "the female is a sex-heterozygote with femaleness dominant," whereas the male is a homozygous recessive. The possibility is, however, admitted that in insects, such as have been studied by Wilson, Morgan and others, the male may be the heterozygous sex, as the cytological evidence suggests.

Double flowers and their peculiar inheritance are considered in a special chapter, following which comes what to many will be the most interesting chapter in the book, "Evidence as to Mendelian inheritance in man." Eye-color and hair-color are shown to be inherited in typical Mendelian fashion, though the evidence is admittedly incomplete. Skin color, in the case of the mulatto at least, seems to be inherited without segregation. Various hereditary diseases and malformations are shown to be inherited as Mendelian dominant characters. Brachydactyly, cataract, color-blindness and a variety of other hereditary

peculiarities are here included. On the other hand albinism and alkaptonuria are recessive in heredity.

The next two chapters deal with exceptions, real or apparent, to Mendel's law, a most profitable field for students of heredity to cultivate; and the last two chapters of Part I. deal with the new light shed on biological conceptions by Mendelian discoveries and the practical application of Mendelian principles. The sociological application made, which will be of general interest, is stated concisely thus:

> To the naturalist it is evident that while elimination of the hopelessly unfit is a reasonable and prudent policy for society to adopt, any attempt to distinguish certain strains as superior, and to give special encouragement to them would probably fail to accomplish the object proposed, and must certainly be unsafe.

This is a conclusion both democratic and sensible, it would seem.

Part II. contains a biographical notice of Mendel, and a translation of Mendel's two published papers on hybridization, together with a very complete bibliography, an index of subjects and one of authors.

The book as a whole will be quite indispensable to the student of heredity; the general reader will find in it much of absorbing interest, although parts will be found too technical for him to follow readily, unless he too will become, as he will be tempted to become, a student of heredity.

W. E. Castle

Hints for Crystal Drawing. By Margaret Reeks, with preface by Dr. John W. Evans, Imperial College of Science and Technology, London. Longmans, Green and Co. 1908.

The accurate construction of crystal figures usually offers considerable difficulty to the beginner and it was with a view of eliminating some of these difficulties as well as adding a few short-cut methods that this book of 148 pages with its 44 plates of drawings was published.

Of the various types of projections used by the mineralogist the one known as the clinographic projection is now usually employed and it is this projection which is chiefly considered. This is discussed in chapter I.

Chapters II. to IX., or fifty pages of the book, are devoted to directions for the drawing of crystals of the cubic system. The first three classes of this system are treated quite thoroughly and the plates illustrating a few of the common combinations aid the student in following the directions given. The tetragonal system is discussed in ten pages, the hexagonal in twenty, the orthorhombic in fourteen, and the monoclinic and triclinic in fourteen and nine, respectively, while the last eighteen pages are devoted to a consideration of twinned crystals.

In the construction of the axial crosses as well as in the drawing of the more complicated forms, the orthographic plan is first drawn and by dropping vertical projectors the corresponding points on the clinographic projection are located. This is a decided help to the beginner in pointing out the relationship existing between the two types of projections as well as for locating various points in the drawing itself.

But the text is not entirely free from criticism. The treatment throughout is from the standpoint of an experienced draftsman rather than from that of a skilled crystallographer. A few examples will make this point clear.

In the drawing of the tetragonal trisoctahedron $\{211\}$ (Fig. 1, p. 29) the intersection line *P*, 3 between the faces designated by II. and III. does not check with one found by the intersection of the two planes indicated. In Fig. 1, p. 35, the location of the point *X* can hardly be considered as accurate. The drawing of the tetragonal bisphenoid (Fig. 4, p. 65) is incorrect, for its edges should be parallel to lines joining the ends of the crystallographic axes. In the figure on page 79 the crystallographic axes are poorly drawn.

In all of the above-mentioned instances the general direction of the lines is correct, but carelessness in construction is clearly evident. This is to be regretted, for in a treatise on crystal drawing the figures should by all means be accurate. How can a student be

expected to construct correct crystal drawings if the text to which he naturally turns for comparison is lacking in this? If some of the figures had been drawn on a larger scale and then reduced these errors would have been to some extent eliminated.

Fig. 3, p. 51, is given as a combination of the plus and minus diploids. What the author has really drawn is a left gyroid (pentagonal icositetrahedron). Diploids are symmetrical to three principal planes of symmmetry whereas gyroids lack these elements. The figure of chrysolite on page 105 is very poor, as the lines of intersection of the bipyramid (111) with both the macro (101) and the brachy (021) domes are incorrect.

The method of determining the position of the axes of the triclinic system is an ingenious one, being a graphic solution of a spherical triangle when three sides are given. The last chapter on twinned crystals is very instructive, as the author gives numerous practical suggestions which are of great service in the construction of these difficult forms.

The work as a whole is a marked contribution to the science of crystal drawing and is a valuable reference book in spite of the errors referred to above. WALTER F. HUNT

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The Chemical Constitution of the Proteins. R. H. ADERS PLIMMER, D.Sc., Assistant Professor of Physiological Chemistry in, and Fellow of University College, London. In two parts. Part I. London and New York, Longmans, Green and Co. 1908.

This volume forms one of a series of monographs appearing from time to time, covering selected topics in biological chemistry and written by investigators in the subjects dealt with. The contents are divided into the chemical composition of the protein molecule and the chemical constitution of its units, or the discovery and synthesis of the amino acids. The introduction gives a list of the proteins according to the British classification followed by a complete list, with their structural formulæ, of the various protein nuclei thus far discovered. The first section consists of a short survey of the methods employed for the decomposition of the proteins; this is succeeded by a detailed account of the method of isolation and estimation of the monamino and diamino acids, the former following the ester method of Fischer with some variations suggested by Levene and the latter employing the method described by Kossel. The results of the analyses of the various proteins made by the several authors are given in tabular form. The collection of this data and presentation in compact form forms one of the chief advantages of the book. The second section is but a compilation of data relating to the many protein nuclei covering the date of their discovery, determination of their constitution, and methods of preparations by synthesis. Some of these details have been tabulated at the end with the specific rotatory power of the natural and synthetic amino acids, mentioning by whom the observations were made. The book closes with a complete bibliography including about 500 titles and index.

The function of such a compilation must naturally be somewhat circumscribed. It can only be of value as a bibliography mainly and as a source of supply of somewhat complete data for the busy teacher who would utilize this book rather than investigate the original communications. The synthetic reactions are described by equations with structural formulæ which are undoubtedly a valuable aid to their proper understanding and elucidation. The contents are too detailed for the student; investigators and teachers would probably prefer to consult the original articles.

Practical Physiological Chemistry. A Book Designed for Use in Courses in Practical Physiological Chemistry in Schools of Medicine and of Science. By PHILLIP B. HAWK, M.S., Ph.D., Professor of Physiological Chemistry in the University of Illinois. Second edition, revised and enlarged. Philadelphia, P. Blakiston's Son & Co. 1909.

In the revision of the book the author has placed at the beginning a new chapter of

twenty pages discussing the enzymes, and the nomenclature of the proteins has been altered to correspond to the system adopted by the American Chemical Society. Otherwise the changes limit themselves to additions of new reactions in order to bring the book up to date. Although the book contains more material, the publishers have decreased the margins and thickness of the paper, so that the book appears smaller. It becomes somewhat difficult to indicate the exact purpose of this volume. At present it is in the transitional stage between a practical manual and a text-book. It is too bulky for a laboratory book; there is too much discussion of theoretical considerations, and many things are introduced which should not under any conception come into a laboratory course in physiological chemistry, *e. g.*, microscopical examination of urine for casts, etc., and counting of red and white blood cells.

Fortunate indeed would be the instructor of physiological chemistry in a medical school who could be allowed enough time in the curriculum to cover one half of the material between the covers. The book serves an excellent purpose as a reference book of test reactions, but in their multiplicity the student or the practitioner who wishes to become acquainted with a few of the most reliable tests would find himself bewildered and require additional advice in the matter. Were it not for its size and the necessity for such a decided picking and choosing of topics adapted for student laboratory work, the book would serve its purpose admirably. The contents are thoroughly reliable and the tests are given with sufficient detail so that the results should be satisfactory. The many figures and colored plates scattered throughout are excellent.

Upon the whole, the author is to be complimented and those interested in the subject congratulated upon the benefit derived by the publication of the revised edition.

H. C. Jackson

ANTHROPOLOGICAL PUBLICATIONS OF THE UNIVERSITY OF CALIFORNIA IN 1908

The University of California Publications in American Archeology and Ethnology have received during 1908 the addition of nine papers. These comprise volume 6, numbers 1, 2 and 3; the completion of the seventh volume, numbers 2 and 3; and volume 8, numbers 1, 2, 3 and 4. These papers embody the further results of the Ethnological and Archeological Survey of California which the university undertook a number of years ago, and which has since been pushed rather steadily towards completion. The weight of work published in the past year has fallen upon the ethnological side of the problem, rather than upon the archeology and linguistics of the state as in previous years.

In this definite field of ethnology a balance has been maintained in some degree between the northern, the southern and the central portions of the state. The two bulkiest papers of the period, Dr. Barrett's "Ethno-geography" and "Basketry" of the Pomo, treat of the peoples of the north-central region. These two are the most exhaustive treatments of their type that have appeared so far. The minuteness of the author's information concerning the region rests on long residence among the Pomo, in addition to extended scientific study. As a counterpoise to this work on the Pomo, four less laborious papers have been devoted to the "Mission" Indians of the extreme southern part of the state. Two of these latter are by Dr. Kroeber and the other two by authors from outside the university. As regards the central portion of the state, the rather varied territory occupied by the Miwok or Moquelumnan tribes offers the problem which is taken up in two of the three remaining papers.

An entirely different aspect of the ethnology of California is invaded by the final paper of the group, by Dr. William J. Sinclair. This paper enters with effect into the question of the geological relation of human remains and artifacts within the state of California. The range covered in the past season's publications is therefore seen to be rather wide. They perhaps contribute more manifoldly than is usual in a brief twelvemonth, to the general information concerning the state on its many sides as an ethnological field.

The Ethno-geography of the Pomo and Neighboring Indians, by S. A. Barrett. Vol. 6, Number 1.[1] Dr. Barrett's method in this, the largest of his three papers, includes the determination of certain dialectic areas in the Pomo territory, with sections of similar provinces among the Wintun, Yuki and Moquelumnan peoples. This is accomplished by means of vocabularies, together with comparison of the different phonetic systems. Of the seventeen areas isolated by Dr. Barrett in the paper, seven are Pomo, five Yuki, two Wintun and three Moquelumnan. A large map accompanying this treatise outlines the dialectic provinces established and makes clear their geographical relations to each other. In addition, the author has entered on his map 500 of the aboriginal village and camp sites of the Pomo, and some of the more important villages of the neighboring stocks. The work as a whole comprises, besides the maps, comparative vocabularies of 282 words in sixteen Pomo, Yuki, Wintun and Moquelumnan dialects, an extended introduction, discussion of phonetic and linguistic relationships, descriptions of village sites, and a full glossary of native words which enter into geographical names.

Pomo Indian Basketry. Vol. 7, Number 3. In this companion volume the author takes up with some minuteness the subject of the baskets and basket designs of the same people. The paper treats exhaustively of forms, technique, ornamentation and the native nomenclature of the designs. This people is particularly facile in handling decorative elements and surpassingly excellent in technique. Dr. Barrett's paper covers both aspects of his subject at length, in discussion as well as by photographic and diagrammatic illustrations. The work includes 231 text figures and 30 plates, together with a full glossary of native basketry terms. Like his former paper, it is more full and minute in outline than anything of similar nature which has been elsewhere attempted for California territory.

[1] Cite as: *Univ. of Calif. Publ. in Amer. Arch. and Ethn.*

Geography and Dialects of the Miwok. Vol. 6, Number 2. This paper is somewhat similar in outline to the "Ethno-geography," but is less comprehensive in scope. Like the former paper, it includes brief comparative vocabularies and a map indicating the results determined. Some of the vexed issues of the paper are taken up in a following number by Dr. Kroeber:

On the Evidence of the Occupation of Certain Regions by the Miwok Indians. Vol. 6, Number 3. The subject is an interesting one, in that the people concerned were in former times very important numerically, but were among the first to suffer at the advent of the whites. Since then the western units of the stock have so far disappeared that information is extremely scanty. This article, therefore, while necessarily brief, is most important and fills a place in the series which would otherwise tend to be much neglected from lack of proper material.

A Mission Record of the California Indians, by A. L. Kroeber. Vol. 8, Number 1. An entirely new departure is signalized by this paper from Dr. Kroeber. The material which he presents with editorial comments is drawn from authentic documents of the Mexican government written in Spanish, copies of which are in the possession of the Bancroft Library of the University of California. Material of such nature has double or triple interest in that it concerns the peoples who have been under the direct influence of the missions, and have therefore experienced violent modification of their original native customs and conditions. It antedates, moreover, in most instances, such systematized comments as are elsewhere extant concerning native American life. The original manuscript in the present instance is a "contestacion" or codified answer to a list of queries sent to the missions by the Mexican vice-regal government, and contains much that is in the first degree interesting and suggestive. The record as published includes only those parts of the original which are of direct ethnological interest. The significance of the study can be somewhat realized when it is learned that it embodies shorter

or longer statements concerning the conditions, in 1811, at sixteen of the missions. In this document is contained almost the only information at present available concerning the peoples originally around such places as San Luis Obispo, Monterey, Santa Cruz or San José. It is greatly to be desired that further sources in this field may be made accessible.

The Religion of the Luiseño Indians of Southern California, by Constance Goddard DuBois. Vol. 8, Number 3. The paper just mentioned affords an introduction to the recent studies of the Mission Indian region. Of special interest in connection with it is Miss DuBois's paper on the native religion of one part of the area. As in the case of Dr. Barrett's Pomo work, the problem which this author set herself was a definite one, and the fact that she spent some years in intimate association with the Mission peoples gave her an insight into many details. Many of the matters merely indicated or suggested by the Spanish document just touched upon are by Miss DuBois, fully discussed and described in intimate detail. Her paper covers the beliefs and ceremonies of the Luiseño, a Shoshonean people living about San Luis Rey, and includes some account of their mythology. She devotes 186 pages and four plates to the subject. The comparison of such recent and specialized research with the old Spanish commentaries, so far as they exist or may be brought to light, will always be particularly interesting and fruitful.

Ethnography of the Cahuilla Indians, by A. L. Kroeber. Vol. 8, Number 2. From another standpoint this ethnography of the Cahuilla, a second member of the so-called Mission Indian group, opens a no less stimulating field of inquiry. The Cahuilla are the least known of the three modern mission tribes. Dr. Kroeber outlines their geographical position, discusses their varied environment, and deals in detail with their material culture. His paper points to the necessity of including the Cahuilla with the "southern" cultural group of California. The text is accompanied by fifteen plates.

The Culture of the Luiseño Indians, by Philip Stedman Sparkman. Vol. 8, Number 4. Somewhat similar in general outline to the paper just mentioned is this treatise on the culture of the Luiseño. The author, who lost his life in the field, studied the people through a number of years, especially from the standpoint of their language. The present paper represents only a single aspect of his work among them. In it he takes up the most prominent facts of their culture and habitat, and discusses briefly their arts and crafts, their social institutions, and some of the more important features of their religion. At the close of the paper he catalogues the plants which were of importance to the primitive Luiseño, and designates their various uses. The paper is probably the least important of three excellent studies by the same author, all of which are shortly to be consigned to print.

Recent Investigations Bearing on the Question of the Occurrence of Neocene Man in the Auriferous Gravels of the Sierra Nevada, by William J. Sinclair. Vol. 7, Number 2. For upwards of forty years the vexed question of the appearance of man in Tertiary strata of California has called forth a great deal of testimony, pro and con. The question has centered to some degree around a small number of specimens, physical and cultural, found originally in the region of Tuolumne, Calaveras and El Dorado counties on the western slope of the Sierra Nevada. This testimony has been collated and reviewed by Mr. Sinclair in the present paper. The outcome of this latest study on the question quite possibly lays the whole matter at rest. Mr. Sinclair holds that in the face of all that has been said and written, no competent evidence of Tertiary man in California has ever to the present time been adduced. His work lies along both original and critical lines of study, and deals with first-hand evidence obtained by personal research on the ground.

In general interest, therefore, the papers of the twelvemonth just passed may be seen to cover a wide field, both geographically and in

range of subject matter. They indicate that the work now being done by the university is thoroughly specialized, and is organized on the broadest possible basis. The number of contributors is larger than in any previous year, and includes authors of a wide range of training and interest. In total bulk, the contributions of the period just passed (782 pages, 38 plates, 235 text figures and 3 maps) are larger than ever before in the history of anthropological work in California.

THOMAS WATERMAN

BOTANICAL NOTES

ANOTHER KEY TO SACCARDO

A COUPLE of years ago a brief notice was made in SCIENCE of a typewritten English key to Saccardo's "Sylloge Fungorum" prepared for the use of the mycological students in the University of Nebraska, and the statement was made that a few extra copies might be obtained on application. The results of the announcement were surprising. At once requests for the key came from all parts of the country, and within a week the small stock of the books was all sold out, and it became evident that a reissue or a new edition must be prepared. This has now been done by Professor Dr. Clements, of the University of Minnesota, and proof is now being read upon the new edition, which is to be printed and brought out as a small book. It will contain keys to "spore sections," to orders and families, and to the genera, besides some handy indexes, glossaries, etc. As it has been announced to be "ready by September 20" further notice may be deferred until the appearance of the completed work. In the meantime those who are especially interested in it may communicate with the author, as above, at Minneapolis.

A NEW COLORADO BOOK

PROFESSOR RAMALEY, of the University of Colorado, has given us in his "Wild Flowers and Trees of Colorado" a charming little book intended to serve as an introduction to Colorado plants. In less than a hundred pages he leads the beginner far on the road to a knowledge of the vegetation of this state. He first discusses the general aspects of Colorado vegetation (ecology we often have called it in these later years) and then takes up the forests and forest trees of the state. He recognizes five zones or belts of vegetation, namely, the plains zone, foothill zone, montane zone, sub-alpine zone and alpine zone. These are admirably illustrated by many half-tone reproductions of well-selected photographs. The forest trees are briefly described by means of convenient keys, and the text is helped greatly by many illustrations. A bibliography including thirty-one titles completes this very useful book.

THE MINNESOTA BOTANICAL STUDIES

THE resumption of publication of the widely-known "Minnesota Botanical Studies" is a matter of more than ordinary interest to botanists. The "Studies" were begun fifteen years ago by Professor MacMillan, under whom two fine volumes were completed, and parts 1, 2 and 3 of the third volume were issued, publication ceasing five years ago. Now under Professor Clements, part 1 of volume IV. makes its appearance with the same style of cover, paper and typography. In the present part, which covers 132 pages, there are six papers, viz: "Embryo-sac Development and Embryology of *Symplocarpus foetidus*," by C. O. Rosendahl; "The Seeds and Seedlings of *Caulophyllum thalictroides*," by F. K. Butters; "Influence of Physical Factors on Transpiration," by A. W. Sampson and L. M. Allen; "Two Basidiomycetes New to Minnesota" and "The Pezizales, Phacidiales and Tuberales of Minnesota," by D. S. Hone; "A New Genus of Blue-green Algae," by F. E. Clements and H. L. Shantz. The promise is made, also, that an index and title page "will be furnished at an early date" for the three preceding parts which are to constitute volume III.

RECENT SYSTEMATIC PAPERS

WE may briefly notice the following contributions from the United States National Herbarium: Henry Pittier's "New or Note-

worthy Plants from Colombia and Central America" (XII., 5), with two plates and nine text figures; A. S. Hitchcock's "Grasses of Cuba" (XII., 6); J. N. Rose's "Studies of Mexican and Central American Plants—No. 6" (XII., 7); with eight plates and twenty-nine text figures; Paul C. Standley's "Allionaceae of the United States, with Notes on Mexican Species" (XII., 8) with sixteen plates and nineteen text figures; Britton and Rose's paper on "*Thompsonella*," "*Echeveria*" and "New Species of Crassulaceae" (XII., 9) with five plates; Britton and Rose's "Genus *Cereus* and its Allies in North America" (XII., 10), with sixteen plates; J. N. Rose's "Five New Species of Crassulaceae from Mexico" (XII., 10), with five plates; Coulter and Rose's "Supplement to the Monograph of the North American Umbelliferae" (XII., 10), with two plates; and G. N. Collins's "Apogamy in the Maize Plant" (XII., 10), with two plates showing the replacement of the staminate flowers by young leafy, and root-forming maize plants; and Wm. R. Maxon's "Studies of Tropical American Ferns—No. 2" (XIII., 1), with nine plates and one text figure, and including descriptions of many new species.

Much botanical activity is shown by the two recently issued "Contributions from the Gray Herbarium of Harvard University" (XXXVI. and XXXVII.), in the first of which there are papers by Alice Eastwood ("Synopsis of the Mexican and Central American Species of *Castilleja*" and "Some Undescribed Species of Mexican Phanerogams"); B. L. Robinson ("A Revision of the Genus *Rumfordia*," "Diagnoses and Transfers of Tropical American Phanerogams"); and H. H. Bartlett ("A Synopsis of the American Species of *Litsea*," "Notes on Mexican and Central American Alders," "The Purple-flowered Androcerae of Mexico and the Southern United States" and "Descriptions of Mexican Phanerogams"). It is worthy of notice that all descriptions and keys, whether generic or specific, are given in Latin, in accordance with Article 39 of the Vienna Code. The second contribution is John R. Johnston's "Flora of the Islands of Margarita and Coche, Venezuela," and consists of a general discussion of the vegetation, and controlling physical factors, an annotated catalogue of species, lists of the economic plants, distribution, and composition, etc. The paper, which covers about 150 pages, is accompanied by two maps of the islands, and six plates illustrating the vegetation or structural details of the plants.

E. L. Greene resumes the printing of his "Leaflets" (Vol. II., 1–24, February, 1909) by the publication of four papers—"New Species of the Genus *Mimulus*," "New Western Asteraceae," "New Composites from Oregon, Washington and Idaho" and "New Plants from Arizona."

Here may be noticed Rosendahl and Butters's "Guide to the Ferns and Fern Allies of Minnesota" intended to enable students to identify the sixty species of these plants found in the state. This is accomplished by means of keys, plates and text figures, all of which are excellent.

"The Forests of Mindoro," by M. L. Merritt, of the Philippine Bureau of Forestry, is a fifty-page pamphlet of much interest to both foresters and botanists. It is intended to give some idea of the country, the distribution and the composition of the forest areas of the island of Mindoro. This island lies about a hundred miles southwest of Manila, and contains a little less than four thousand square miles. A mountain chain extends its whole length, rising at one point to 8,500 feet, and this is bordered with foothills and broad alluvial coastal plains. Nearly two thirds of this area is covered with forests, the remainder is nearly all uncultivated grass lands, only about one per cent. being under cultivation. The report, which is illustrated by ten half-tone plates, and a map, closes with a "list of tree species collected in Mindoro and smaller adjacent islands," numbering 560 species. When we remember that these occur upon an area equal to about half a dozen counties the richness of the forest flora may be appreciated.

C. B. Robinson's "Philippine Chloranthaceae" and "Philippine Phyllanthinae" (*Phil. Jour. Science*, April, 1909) includes a sys-

tematic treatment of the genera and species of these two groups, the first with but two genera and three species, the second with seven genera and fifty-four species.

Here should be noticed the recent "Heften" (3, 4, 5, seventh series) of Karsten and Schenck's "Vegetationsbilder." The first of these by Otto Feucht illustrates the Black Forest; the second, by L. Adamovic, deals with Dalmatian vegetation, and the third, by Felix Rosen, illustrates the characteristic plants of the Abyssinian highlands. The plates maintain the extraordinarily high degree of perfection which has characterized the previous numbers, and the text is all that could be desired. How the German publisher (Fischer) can afford to publish these Heften for the low price of four Marks each is a source of wonder to American botanists.

RECENT PAPERS ON ALGAE

Professor Griggs's paper "Juvenile Kelps and the Recapitulation Theory" (*Am. Nat.*, January and February, 1909) takes up a profitable line of inquiry as to the young stages of many of the large brown sea-weeds, giving especial attention to *Renfrewia, Lessoniopsis, Egregia* and *Hedophyllum*. He reaches the conclusion, contrary to that of many zoologists, "that though organisms are subject to adaptation at any stage of their life cycles and may gradually cut out superfluous stages, yet, except as some such tendency has operated to change the heritage, the development of the individual does recapitulate the history of the race."

Dr. M. A. Howe's "Phycological Studies—IV." (*Bull. Torr. Bot. Club*, February, 1909) is devoted to a monograph of *Neomeris* (of which there are now known six species); two West Indian species of *Acetabulum;* a new species of *Halimeda* (from the Bahama Islands), and several species of *Udotea*, accompanied with six helpful plates.

Wittrockiella is the very pretty generic name given by the well-known Norwegian algologist, Wille (*Nyt Mag. of Nature*, Cd. 47), to a small, fresh-water chlorophyll-green alga which occurs in the brackish waters of southern Norway in company with *Rivularia, Microcoleus* and other *Myxophyceae*. It is related to *Trentopholia*, and has been made the type of a new family, *Wittrockiellaceae*, of the order *Chaetophorales*.

Other papers on algae are Otto Müller's "Ortsbewegung der Bacillariaceen," VI. and VII.; A. Scherffel's "Asterococcus," and "Schizochlamys" and N. Wille's "Oocystis," in recent numbers of the *Berichte d. Deutschen, Bot. Gesellschaft*.

A HANDFUL OF FUNGUS AND PATHOLOGICAL PAPERS

One of the best-printed bulletins on fungi that has come to notice is Dr. N. A. Cobb's "Fungus Maladies of the Sugar Cane," issued by the Experiment Station of the Hawaiian Sugar Planters Association (Bull. No. 6, of Division of Pathology and Physiology). The paper, printing and illustrations are remarkably fine. The text will prove interesting to most botanists, especially those who have not followed strictly the latest developments in plant pathology. Thus the stinkhorns (Phallaceae) are shown to be associated with a root disease of the sugar cane, and species of *Ithyphallus, Dictyophora* and *Clathrus* are described as pretty certainly responsible for the injury. Other diseases of the cane, as "tip wither," "ring spot," "eye spot," "rind disease," etc., are described and remedies suggested. With this portion of the text there are seven elegant colored plates. The closing chapter is devoted to "timber rots," and here the text illustrations are unusually fine.

From the Bureau of Plant Industry of the United States Department of Agriculture we have a bulletin on "The Control of Black-rot of the Grape," by Messrs. Shear, Miles and Hawkins, in which the conclusion is reached that proper spraying with Bordeaux mixture is effective in preventing the disease. Other papers from the bureau are J. R. Johnston's Bud-rot of the Coconut Palm" (thought to be due to bacteria); Perley Spaulding's "European Currant Rust on the White Pine in America" (a recent importation); the same author's "Present Status of the White Pine Blights" (a very useful summary of what is known of this "complex of several different

diseases"); and Metcalf and Collins's "Present Status of the Chestnut Bark Disease" (due to *Diaporthe parasitica*, which thus far has baffled all attempts at control, by anything less than the destruction of the diseased trees).

In Dr. Clinton's "Report of the Station Botanist" (Conn. Agricul. Expt. Station, 1908) he takes a more hopeful view of the future of the chestnut bark disease, believing that the trouble is largely due to "winter injury" rather than to the fungus above named, and that it "is now probably about at the height of its development, so that not much additional harm may be expected." Another paper in the same report takes up another puzzling disease, peach yellows—and here, also, a suggestion is made as to its nature which at least has the merit of some probability. The closing paper gives the results of artificial cultures of *Phytophthora* of different species. This will be most useful to mycologists who may wish to introduce this method of study in their laboratories.

Other papers which may be mentioned here are Professor DeLoach's "Studies on the *Colletotrichum gossypii*" (Bull. 85, Georgia Expt. Station); W. T. Horne's "Report of the Department of Vegetable Pathology" in the report of the Estacion Central Agronomica of Cuba (1905–09), and an earlier one by the same author devoted to coconut diseases (Bull. 15); Freeman and Johnson's "Loose Smuts of Barley and Wheat" (Bull. 152, Bureau of Plant Industry); C. W. Edgerton's "Perfect Stage of the Cotton Anthracnose" (*Mycologia*, May, 1909); the same author's "Anthracnose or Pod Spot of Beans" (Bull. 116, La. Expt. Sta.); J. G. Grossenbacher's "Mycosphaerella Wilt of Melons" (Tech. Bull. 9, N. Y. Expt. Sta.); and G. W. Wilson's "Notes on Peronosporales for 1907" (Bull. Upper Iowa University, XI., 3).

We have space for only brief mention of the following, also: Century XXIX. of "Fungi Columbiani" (Elam Bartholomew, Stockton, Kans.) devoted wholly to fungi collected in Arkansas; Fawcett's "Fungi Parasitic upon Aleyrodes citri" (Special Studies, 1; Univ. Florida), with six plates; Rorer's "Bacterial Disease of the Peach" (*Mycologia*, January, 1909); Edwards and Barlow's "Legume Bacteria" (Bull. 169, Ontario Agricul. Coll.).

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SPECIAL ARTICLES

THE CONSERVATION OF MASS AND THE PASSING OF MATTER

To the Editor of Science: The article by Professor Lewis in the *Technology Quarterly*, discussed in your issue of April 23, 1909, by Professor Speyers, is one answer to the obvious necessity for an enlargement and restatement of some of the fundamental concepts of physics.

The discovery of radioactivity by M. Henri Becquerel, and that of polonium by Mme. Curie, initiating us into the knowledge of a new order of phenomena, together with the observation by P. Curie and Laborde of a continual production of heat by radium, and the splendid experiment of Kaufmann on the variation of mass with velocity, finally the suggestion by Rutherford and Soddy that the atoms of the radio-elements disintegrate with production of helium, confirmed in the face of great difficulties by Sir William Ramsay and Mr. Soddy, have placed before us an array of new facts for which new doctrines are imperatively needed.

We may recall that the investigations of Larmor, J. J. Thomson, Hicks and others, exhibit to us a conception of an atom as a world in miniature, where internal revolutions and reactions of distinct internal entities at enormous speeds give a basis for the discussion of latent energies implied by the physical fact of the inertia of the atom.

That the mass of a body is nothing but the energy of its ethereal rotation is a view which I have held tentatively. Following the equations used by Professor Lewis, and introducing this further premise, let $M =$ momentum, $M' = Mr =$ angular momentum, or "moment of momentum," of the ether, where r is the radius of gyration of the reciprocating rotations of the ether. The complex of these integrated rotations constitutes an electromagnetic wave whose amplitude diminishes with r as the spherical wave-front expands. Let

P = normal radiation-pressure corresponding to the radiant energy per unit of volume of the ether = ethereal moment of momentum transferred per unit of time to a normal surface; m = the mass of a body, an atom for example, E, its energy, either actual or potential, v, its velocity; V = velocity of light; and t = time. Then according to the Maxwell-Bartoli formula,

$$P = \frac{(1+\rho)}{V} \times \frac{dE}{dt}$$

where ρ is the reflecting power of the surface which receives the radiation. Under the action of this radiant pressure, there is a transference of energy from the ether to matter which may be regarded as the transferring of a definite amount of angular momentum from the ether to matter, according to the equation

$$M'/t = dE = dm \times V^2. \qquad (1)$$

Whether the energy received by an absorbent particle from radiation shall be manifested in the body as kinetic energy of mechanical motion, or as thermal energy, is a detail depending on whether the particle is free to move, or is constrained by its linkage to other particles.

We may distinguish between the free ether and the ether which is bound in material vortical motion; but in a slightly different sense the ether can never be said to be free, for it is everywhere in contact with itself. The angular momentum of a free material body is invariable. It can not be altered from within, and can only be transferred by contact. But the angular momentum of the ether which is everywhere in contact is always transferred. Mass, as a property of ether, is purely temporary. The ethereal mass is strictly proportional to the radiant energy and disappears with it. Equation (1) which expresses a relation between ether and matter, may, however, be applied to the ether alone, if m and E denote its transient mass and energy during radiant activity.

The earth, by virtue of its orbital motion, possesses a great store of potential energy for the production of heat. An atom, by virtue of the internal motions of its electrons, possesses a relatively enormous potential energy. Neither of these stores of energy can be converted into heat except by some sort of collision which disturbs and disarranges the harmonious motion. The distinction between actual and potential energy depends upon the point of view. The kinetic energy of terrestrial orbital motion is actual mechanical energy, but in relation to thermal energy the kinetic energy is potential. Upon this energy of a planet's orbital revolution there are superimposed the kinetic energy of its axial rotation, that of the motion of the entire solar system along the sun's way, relatively to the gravitational center of motion in the galactic agglomeration of which our sun forms a part, and the unknown motion of the galaxy as a whole, relatively to some point in absolute space. The total energy of a body is an unknown quantity, save as it becomes theoretically possible to predict it in the way that Professor Lewis has pointed out.

Recognizing that only a small part of the total energy-content of a body comes within our cognizance, and that comparatively only a brief interval in its history can come under observation, I think that we may, with all humility in acknowledgment of our limitations, nevertheless find in the relations between light and matter an epitome of the history of the physical universe. If mass can be transferred through light, it follows that mass may be said to *originate* from light, that is, from ethereal rotation so circumstanced that the motion becomes circumscribed and the energy prevented from dissipation by ordinary agencies.

The mechanical action of light observed by Crookes, although not certainly separated by him from mechanical action due to the residual gas of his vacuum tubes, has now been completely demonstrated by Lebedew, and by Nichols and Hull, and has been shown by the latter to be independent of the wave-length, and in agreement with the prediction from electromagnetic theory.

Although the rapid motion of finely divided matter in comets' tails may be explained on the hypothesis of electric repulsion, the demand for a large solar electric field has been

considered a difficulty, and astronomers have welcomed the suggestion that this motion and that of similar material in the solar corona may be due to light-pressure. The acceleration produced by solar gravity at the earth's distance being

$$\frac{0.593}{982.15}=\frac{1}{1656}$$

of the acceleration by terrestrial gravity at the surface of a spherical earth, the light-pressure from solar radiation at this distance on a body of small size whose receiving surface is very large compared with its volume and mass, may exert an accelerative action several times that due to solar gravity, the differential acceleration giving an accumulating velocity away from the sun.

Professor Edwin B. Frost and Mr. J. A. Parkhurst find from their spectroscopic observations of Comet Morehouse that "particles of the same [chemical] constitution are thrown out from the head at angles at least 40° asunder."[1] Bredichin's hypothesis in explanation of cometary tails of various types requires in this case that the particles forming individual component streamers of the tail shall be of different sizes, rather than of different sorts, since the several chemical compounds are not distributed unequally, but are everywhere indiscriminately mingled. No change of composition whatever occurs through a stretch of several degrees of the comet's tail, so far as can be inferred from the spectroscopic evidence.

If the masses of the particles have been changed, it may be asked, will there not be a change in the spectrum? Perhaps not in this case. The change of mass corresponding to the velocity observed in the particles of a comet's tail will be very small, according to the results of Kaufmann's experiment, and need not necessarily produce any sensible change in the spectrum; but at high velocities approaching that of light, such changes would be anticipated, and we have evidence that such changes do occur. It has long been known that vacuum tubes filled with various gases most carefully prepared for exhibition of their several spectra, suffer gradual change, the spectra being eventually reduced to other and simpler ones until at last possibly nothing but hydrogen remains. Attempts to explain this behavior on the supposition of the presence of impurities, or by the occlusion of gases in the walls of the tube, and the gradual absorption or emanation of such residual gases, have been only partially successful. The true explanation which finally emerges is that the atoms of large atomic weight are eventually broken down as a result perhaps of repeated collisions at high speed under electric repulsion, and are resolved into simpler atoms. Sir J. J. Thomson finds that the positive rays in high vacua, where great velocities have been electrically produced, consist of particles of not more than three sorts which are probably hydrogen, the alpha particle, and helium, and that this is so *no matter what gas is put into the tube.* It is notable that the luminous emanation from *Nova Persei* appeared likewise to consist of particles of *three* sorts, and having masses *in the same ratio* (1 : 2 : 4) as those observed in the vacuum tube. I think, therefore, there can be no doubt that the nebulosity around *Nova Persei* was an example on an enormous scale of Goldstein's "canal rays."

The recent observations of Comet Morehouse are not clearly decisive for or against the theory of light-pressure. Barnard finds that the motion of luminous knots along the tail is unaccelerated. The development of a comet's tail takes place at the rate of something like 100 km. per second, and is maintained unaltered through distances comparable to that separating the sun from the earth. This result was obtained in a vague way many years ago by Olbers and others, but from observations which rested on the very uncertain limit of the visibility of the extremity of a comet's tail. Barnard's observation is more precise, and is in agreement with the hypothesis of a force whose acceleration diminishes as a result of the motion imparted by its own action.

Next in importance to the observed velocity must be placed any information which can be obtained as to the size of the particles. The

[1] *Astrophysical Journal*, 29, 63, January, 1909.

spectroscopic measures of Comet Morehouse at the Yerkes and Lick Observatories show that the light from the tail proceeds almost entirely from gaseous molecules. But Schwarzschild has shown that there can be very little light-pressure on free gaseous molecules, because their dimensions are so small that they diffract the light and remain themselves comparatively unaffected. If the motion is due to pressure of light, it would seem to follow that the gaseous spectrum of the comet's tail must be that of small separate atmospheres enveloping and attending moving particles which are not otherwise visible, but are the objects directly impelled by the luminous impact. A gradual diminution of size of the particles by electric dissipation or by evaporation would give a diminishing efficacy to the repulsion, but whether this would be compatible with the observed motion can not be determined.

The cometary evidence being indecisive, the argument for the interaction of ether and matter must rest for the present on the observed mechanical pressure of light, and on Kaufmann's experiment, with the addition of such inferences as are suggested by the phenomena of radioactivity and the behavior of matter in highly exhausted vacuum-tubes.

The variety of new properties of matter observed with a high vacuum is sufficiently extraordinary. The interior of a vacuum tube is virtually a new world, where the physical laws with which we are familiar are in appearance frequently contravened. According to the ordinary laws of gases, any gas set free in a vacuum-chamber might be expected to diffuse almost instantly to every part of the exhausted volume. Nevertheless, in heating the gas-regulator of an X-ray tube to restore a minute amount of gas to a tube of too high resistance, the gaseous matter may be seen trickling along the walls of the tube in a network of apparently viscous filaments, the gas behaving as if it were a viscid liquid, adhering to the walls of the tube and reluctant to leave them.

In my paper "An Inquiry into the Cause of the Nebulosity around Nova Persei"[2] I have shown that particles analogous to those of cathode rays were shot off from the star with velocities in some cases scarcely inferior to that of light; and yet, at distances from the center of dispersal which are comparable with those from star to star, the motion bore witness to a control which was not gravitational, but resembled rather a magnetic control emanating from the star. The mere suggestion that a magnetic field can exist at stellar distances capable of guiding particles, of any kind whatsoever, will evoke the exclamation "impossible!" But having learned from the behavior of vacuum-tubes that many very strange phenomena are of every-day occurrence in these novel realms of vacuous space, it may be well to enlarge the bounds of preconceptions.

Professor Speyers's equation (7) does not fit the facts, but his equation (8), which agrees with that given by Professor Lewis, conforms to the data of observation. The source of the discrepancy comes from a failure to distinguish between the mass of the ether and that of the body receiving radiation. If, for clearness, we call the former m' and the latter m,

$$dE = V^2 m' = V^2 dm,$$

and

$$V dm = mv = M$$

(if the velocity of the body receiving the radiation is wholly due to light-pressure, M being the temporary momentum of the ether), whence, since $m = m_0 + dm$,

$$dm/m_0 = v/(V - v).$$

This equation may be substituted for equation (7).[3] It gives for the mass of a particle moving at any velocity up to that of light,

$$m_0 + \frac{dm}{m_0} = m_0 + \frac{v}{V - v} = m_1,$$

or

$$m_1 - m_0 = v/(V - v)$$

and

$$m_1 - m_0 = \infty,$$

if $v = V$, as the theory of Kaufmann's experiment requires.

In saying that "the mass of the body struck

[2] *American Journal of Science*, July, 1903.

[3] *Loc. cit.*

[by radiation] increases as it moves [faster] . . . but only as it receives *this particular form of energy*,"[4] Professor Speyers is, it seems to me, endeavoring to express a distinction which must be recognized, but in terms which can not be admitted if non-Newtonian mechanics is accepted. The mass of the ether is only temporary; it does not become infinite though moving with the velocity of light, and it can be transferred. There are not, however, two kinds of energy—one the energy of mechanical motion, the other, radiant energy. There is only one energy in the physical universe, but two sorts of mass—temporary for ether, permanent for matter, both of them being energy of ethereal rotation. I am entirely in agreement with Professor Lewis that the substance (meaning by this word no ordinary matter everywhere and at all times amenable to gravitation, nor yet a purely metaphysical substance, but a universal interstellar medium which has physical properties different from ordinary matter) "which in a beam of light has mass, momentum and energy, and is traveling with the velocity of light, would have no energy, momentum or mass if it were at rest"; but "if it were moving with a velocity even by the smallest fraction less than that of light," it would cease to be free ether, and would have quite different properties. Now this is just what might be expected if matter is formed from the ether, for however it may be formed, matter must be differentiated from the ether by a *per saltum* change, ordinarily irreversible. Whether we consider the condensation of a large volume of ether containing a powerful luminous energy into the dimensions of a corpuscle still retaining the electro-magnetic energy of the original volume, or regard the birth of an elementary particle as in the nature of a cataclysm which opens a rift in a medium of great strength and density, in other words, whether we conceive the ultimate particles of matter to be vacuities in an exceedingly dense ether, kept from collapsing by the centrifugal pressure of a rapidly rotating shell, or as condensations in an elsewhere excessively rarefied medium, in either case the circumscribing of a definite volume with properties other than those of the general medium presupposes a surface of discontinuity of some sort around the segregated portion, such as might be produced by a sudden change in the ethereal velocity at this singular surface. It may be a question whether the permanent mass (m_0) of a material body is exactly equal to its ethereal angular momentum divided by the velocity of light

$$m_0 = M'/V.$$

The circumscribing of the ethereal motion may be attended by some departure from the universal velocity in the free ether, but this is simply to say that the materialized ether is distinct from the free ether.

In an article in *Nature*[5] Professor Larmor, in commenting on the fact that the Doppler effect requires "some kind of thermodynamic compensation, which might arise from ethereal friction, or from work required to produce the motion of the body against pressure excited by the surrounding radiation," says: "The hypothesis of friction is now out of court in ultimate molecular physics," but it comes into court again with the discovery that atoms are destroyed and that new radiant energy is thereby imparted to the ether. If radiation, in turn, generates mass, as I have suggested in my paper, "A Cosmic Cycle,"[6] or in the less problematical way which Professor Lewis has now virtually demonstrated, it is difficult to conceive how this can be done without some sort of ethereal reluctance analogous to viscosity in a gas; and granting such a reluctance, we might anticipate some retardation of the normal ethereal velocity in the transformation.

In the paper cited, I have defined energy as "the modification of ethereal rotation, or the establishment of rotation at new points in the ether." Radiant energy is electromagnetic rotation of the ether, differing in no wise essentially from the ethereal rotations within an atom whose energy makes the atomic mass,

[4] *Loc. cit.*, p. 657.

[5] Vol. 63, p. 216, December 27, 1900.

[6] *American Journal of Science*, 13, 193, March, 1902.

save that the latter is very nearly permanent. Not a special velocity *per se*, but the being, or ceasing to be, of a special ethereal rotation is what apparently conditions the phenomenon.

As Mons. Hirn says in his attempt to define energy:[7]

> What we call kinetic energy or mechanical work consists of quantities which are not necessarily bound to the existence of ponderable matter.

To borrow an illustration from Hirn, we may compare the following two ways of heating a bullet. When a projectile, such as a ball of lead, strikes a rigid obstacle, it becomes hot, and the quantity of heat developed (and divided between projectile and obstacle) is rigorously proportional to the external kinetic energy which has vanished for the time being. But we can heat the leaden ball just as well by exposing it to the sun's rays; and here again the temperature, or elevation of thermal activity, is related to the radiant movement extinguished. The kinetic energy of the radiation, which was that of an original radiant beam or column of ether, has been destroyed as radiant energy, but not as essential energy. The energy has simply been transferred; but there is a distinction between the two modes of heating the bullet. The radiant energy extinguished is *completely* transferred to the absorbent. The thermal energy developed by impact is divided between missile and obstacle. This distinction is fundamental, and prevents the identical application of a law expressing the relation between ethereal and material energy, to the interchange of energy between different portions of matter. Kaufmann's experiment belongs to the first category. The distinction, which has no counterpart in the transference of momentum by sound waves or water waves, has its place in the system proposed by Professor Lewis. The kinetic energy of a mass which moves with the velocity of light is mV^2, but that of a mass moving with the ordinary velocities with which we have to deal in Newtonian mechanics is $\frac{1}{2}mv^2$. That the distinction is not an absolute one, but that for velocities somewhat slower than that of light, the mathematical expression for kinetic energy passes through intermediate values, is a view which reconciles these diverse modes of subdivision of energy.

I venture to suggest that Mr. Speyers's difficulty in regard to the lesser velocity of light in water is not a real one; because owing to innumerable, minute, alternating deflections of the light ray in passing through the bound ether attached to the molecules, the path of the light is lengthened. There is no necessary change in the true ethereal velocity.

Ordinarily, the mass of a body of matter can not be transferred; but in radioactivity, and in atomic disintegration and destruction produced in any way, energy returns into the ether, and may be transferred as temporary ethereal mass, just as in the case of radiant energy, of which it is perhaps a special form. The ordinary destruction of atoms is excessively slow, nevertheless every flame involves *some* minute amount of atomic destruction.

The laws of the conservation of mass and of energy require restatement. Taking the universe as a whole, there is always a restoration of mass or of energy which disappears in time at some given point, but in general reappears at some other time or place. Thus if atoms are destroyed in radioactive transformations, there must be some other part of the universe where these atoms are reproduced. Temporarily the energy concerned in the formation of an atom is set free in the destruction of the atoms of radium, evolving enormous quantities of heat. Some of this heat may be immediately transformed and all will be eventually transformed into radiant energy, passing out into the free ether, there to exist for a time as temporary mass until it is again fixed in new forms of *material* substance, for the ether is the great storehouse of energy. Shall an atom outlast a star? Are they not both parts of a fleeting imagery—a series of dissolving views which come and go as the ages move?

FRANK W. VERY

WESTWOOD ASTROPHYSICAL OBSERVATORY,
May 3, 1909

[7] "La notion de force dans la science moderne," p. 47.

SCIENCE

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INAUGURAL ADDRESS OF THE PRESIDENT OF HARVARD UNIVERSITY[1]

AMONG his other wise sayings Aristotle remarked that man is by nature a social animal; and it is in order to develop his powers as a social being that American colleges exist. The object of the undergraduate department is not to produce hermits, each imprisoned in the cell of his own intellectual pursuits, but men fitted to take their places in the community and live in contact with their fellow men.

The college of the old type possessed a solidarity which enabled it to fulfil that purpose well enough in its time, although on a narrower scale and a lower plane than we aspire to at the present day. It was so small that the students were all well acquainted with one another, or at least with their classmates. They were constantly thrown together, in chapel, in the classroom, in the dining hall, in the college dormitories, in their simple forms of recreation, and they were constantly measuring themselves by one standard in their common occupations. The curriculum, consisting mainly of the classics, with a little mathematics, philosophy, and history, was the same for them all; designed, as it was, not only as a preparation for the professions of the ministry and the law, but also as the universal foundation of liberal education.

In the course of time these simple methods were outgrown. President Eliot pointed out with unanswerable force that the field of human knowledge had long

[1] Given by Dr. A. Lawrence Lowell on October 6. Reprinted from the Boston Evening *Transcript*.

been too vast for any man to compass; and that now subjects must be admitted to the scheme of instruction, which became thereby so large that no student could follow it all. Before the end of the nineteenth century this was generally recognized, and election in some form was introduced into all our colleges. But the new methods brought a divergence in the courses of study pursued by individual students, an intellectual isolation, which broke down the old solidarity. In the larger institutions the process has been hastened by the great increase in numbers, and in many cases by an abandonment of the policy of housing the bulk of the students in college dormitories; with the result that college life has shown a marked tendency to disintegrate, both intellectually and socially.

To that disintegration the overshadowing interests in athletic games appears to be partly due. I believe strongly in the physical and moral value of athletic sports, and of intercollegiate contests conducted in a spirit of generous rivalry; and I do not believe that their exaggerated prominence at the present day is to be attributed to a conviction on the part of the undergraduates, or of the public, that physical is more valuable than mental force. It is due rather to the fact that such contests offer to students the one common interest, the only striking occasion for a display of college solidarity.

If the changes wrought in the college have weakened the old solidarity and unity of aim, they have let in light and air. They have given us a freedom of movement needed for further progress. May we not say of the extreme elective system what Edmond Sherer said of democracy: that it is but one stage in an irresistible march toward an unknown goal. Progress means change, and every time of growth is a transitional era; but in a peculiar degree the present state of the American college bears the marks of a period of transition. This is seen in the comparatively small estimation in which high proficiency in college studies is held, both by undergraduates and by the public at large; for if college education were closely adapted to the needs of the community, excellence of achievement therein ought to be generally recognized as of great value. The transitional nature of existing conditions is seen again in the absence, among instructors as well as students, of fixed principles by which the choice of courses of study ought to be guided. It is seen, more markedly still, in the lack of any accepted view of the ultimate object of a college education.

On this last subject the ears of the college world have of late been assailed by many discordant voices, all of them earnest, most of them well-informed, and speaking in every case with a tone of confidence in the possession of the true solution. One theory, often broached, under different forms, and more or less logically held, is that the main object of the college should be to prepare for the study of a definite profession, or the practise of a distinct occupation; and that the subjects pursued should, for the most part, be such as will furnish the knowledge immediately useful for that end. But if so, would it not be better to transfer all instruction of this kind to the professional schools, reducing the age of entrance thereto, and leaving the general studies for a college course of diminished length, or perhaps surrendering them altogether to the secondary schools? If we accept the professional object of college education, there is much to be said for a readjustment of that nature, because we all know the comparative disadvantage under which technical instruction is given in college, and we are not less aware of

the great difficulty of teaching cultural and vocational subjects at the same time. The logical result of the policy would be that of Germany, where the university is in effect a collection of professional schools, and the underlying general education is given in the gymnasium. Such a course has, indeed, been suggested, for it has been proposed to transfer so far as possible to the secondary schools the first two years of college instruction, and to make the essential work of the university professional in character. But that requires a far higher and better type of secondary school than we possess, or are likely to possess for many years. Moreover, excellent as the German system is for Germany, it is not wholly suited to our republic, which can not, in my opinion, afford to lose the substantial, if intangible, benefits the nation has derived from its colleges. Surely the college can give a freedom of thought, a breadth of outlook, a training for citizenship, which neither the secondary nor the professional school in this country can equal.

Even persons who do not share this view of a professional aim have often urged that in order to save college education in the conditions that confront us we must reduce its length. May we not feel that the most vital measure for saving the college is not to shorten its duration, but to insure that it shall be worth saving? Institutions are rarely murdered; they meet their end by suicide. They are not strangled by their natural environment while vigorous; they die because they have outlived their usefulness, or fail to do the work that the world wants done; and we are justified in believing that the college of the future has a great work to do for the American people.

If, then, the college is passing through a transitional period, and is not to be absorbed between the secondary school on the one side and the professional school on the other, we must construct a new solidarity to replace that which is gone. The task before us is to frame a system which, without sacrificing individual variation too much, or neglecting the pursuit of different scholarly interests, shall produce an intellectual and social cohesion, at least among large groups of students, and points of contact among them all. This task is not confined to any one college, although more urgent in the case of those that have grown the largest and have been moving most rapidly. A number of colleges are feeling their way toward a more definite structure, and since the problem before them is in many cases essentially the same, it is fortunate that they are assisting one another by approaching it from somewhat different directions. What I have to say upon the subject here is, therefore, intended mainly for the conditions we are called upon to face at Harvard.

It is worth our while to consider the nature of an ideal college as an integral part of our university; ideal, not in the sense of something to be exactly reproduced, but of a type to which we should conform as closely as circumstances will permit. It would contemplate the highest development of the individual student—which involves the best equipment of the graduate. It would contemplate also the proper connection of the college with the professional schools; and it would adjust the relation of the students to one another. Let me take up these matters briefly in their order.

The individual student ought clearly to be developed so far as possible, both in his strong and in his weak points, for the college ought to produce, not defective specialists, but men intellectually well rounded, of wide sympathies and unfettered judgment. At the same time they ought to be trained to hard and accurate thought, and

this will not come merely by surveying the elementary principles of many subjects. It requires a mastery of something, acquired by continuous application. Every student ought to know in some subject what the ultimate sources of opinion are, and how they are handled by those who profess it. Only in this way is he likely to gain the solidity of thought that begets sound thinking. In short, he ought, so far as in him lies, to be both broad and profound.

In speaking of the training of the student, or the equipment of the graduate, we are prone to think of the knowledge acquired; but are we not inclined to lay too much stress upon knowledge alone? Taken by itself it is a part, and not the most vital part, of education. Surely the essence of a liberal education consists in an attitude of mind, a familiarity with methods of thought, an ability to use information rather than a memory stocked with facts, however valuable such a storehouse may be. In his farewell address to the alumni of Dartmouth, President Tucker remarked that "the college is in the educational system to represent the spirit of amateur scholarship. College students are amateurs, not professionals." Or, as President Hadley is fond of putting it: "The ideal college education seems to me to be one where a student learns things that he is not going to use in after life, by methods that he is going to use. The former element gives the breadth, the latter element gives the training."

But if this be true, no method of ascertaining truth, and therefore no department of human thought, ought to be wholly a sealed book to an educated man. It has been truly said that few men are capable of learning a new subject after the period of youth has passed, and hence the graduate ought to be so equipped that he can grasp effectively any problem with which his duties or his interest may impel him to deal. An undergraduate, addicted mainly to the classics, recently spoke to his adviser in an apologetic tone of having elected a course in natural science, which he feared was narrowing. Such a state of mind is certainly deplorable, for in the present age some knowledge of the laws of nature is an essential part of the mental outfit which no cultivated man should lack. He need not know much, but he ought to know enough to learn more. To him the forces of nature ought not to be an occult mystery, but a chain of causes and effects with which, if not wholly familiar, he can at least claim acquaintance; and the same principle applies to every other leading branch of knowledge.

I speak of the equipment, rather than the education, of a college graduate, because, as we are often reminded, his education ought to cease only with his life, and hence his equipment ought to lay a strong foundation for that education. It ought to teach him what it means to master a subject, and it ought to enable him to seize and retain information of every kind from that unending stream that flows past every man who has the eyes to see it. Moreover, it ought to be such that he is capable of turning his mind effectively to direct preparation for his life work, whatever the profession or occupation he may select.

This brings us to the relation of the college to the professional school. If every college graduate ought to be equipped to enter any professional school, as the abiturient of a German gymnasium is qualified to study under any of the faculties of the university, then it would seem that the professional schools ought to be so ordered that they are adapted to receive him. But let us not be dogmatic in this

matter for it is one on which great divergence of opinion exists. The instructors in the various professional schools are by no means of one mind in regard to it, and their views are of course based largely upon experience. Our law school lays great stress upon native ability and scholarly aptitude, and comparatively little upon the particular branches of learning a student has pursued in college. Any young man who has brains and has learned to use them can master the law, whatever his intellectual interest may have been; and the same thing is true of the curriculum in the divinity school. Many professors of medicine, on the other hand, feel strongly that a student should enter their school with at least a rudimentary knowledge of those sciences, like chemistry, biology and physiology, which are interwoven with medical studies; and they appear to attach greater weight to this than to his natural capacity or general attainments. Now that we have established graduate schools of engineering and business administration, we must examine this question carefully in the immediate future. If the college courses are strictly untechnical, the requirement of a small number of electives in certain subjects, as a condition for entering a graduate professional school, is not inconsistent with a liberal education. But I will acknowledge a prejudice that for a man who is destined to reach the top of his profession a broad education, and a firm grasp of some subject lying outside of his vocation, is a vast advantage; and we must not forget that in substantially confining the professional schools at Harvard to college graduates we are aiming at the higher strata in the professions.

The last of the aspects under which I proposed to consider the college is that of the relation of undergraduates to one another; and first on the intellectual side. We have heard much of the benefit obtained merely by breathing the college atmosphere, or rubbing against the college walls. I fear the walls about us have little of the virtue of Aladdin's lamp when rubbed. What we mean is that daily association with other young men whose minds are alert is in itself a large part of a liberal education. But to what extent do undergraduates talk over things intellectual, and especially matters brought before them by their courses of study? It is the ambition of every earnest teacher so to stimulate his pupils that they will discuss outside the class-room the problems he has presented to them. The students in the law school talk law interminably. They take a fierce pleasure in debating legal points in season and out. This is not wholly with a prospect of bread and butter in the years to come; nor because law is intrinsically more interesting than other things. Much must no doubt be ascribed to the skill of the faculty of the law school in awakening a keen competitive delight in solving legal problems; but there is also the vital fact that all these young men are tilling the same field. They have their stock of knowledge in common. Seeds cast by one of them fall into a congenial soil, and like dragon's teeth engender an immediate combat.

Now no sensible man would propose today to set up a fixed curriculum in order that all undergraduates might be joint tenants of the same scholastic property; but the intellectual estrangement need not be so wide as it is. There is no greater pleasure in mature life than hearing a specialist talk, if one has knowledge enough of the subject to understand him, and that is one of the things an educated man ought so far as possible to possess. Might there not be more points of intellectual contact among the undergraduates,

and might not considerable numbers of them have much in common?

A discussion of the ideal college training from these three different aspects, the highest development of the individual student, the proper relation of the college to the professional school, the relation of the students to one another, would appear to lead in each case to the same conclusion; that the best type of liberal education in our complex modern world aims at producing men who know a little of everything and something well. Nor, if this be taken in a rational, rather than an extreme, sense, is it impossible to achieve within the limits of college life? That a student of ability can learn one subject well is shown by the experience of Oxford and Cambridge. The educational problems arising from the extension of human knowledge are not confined to this country; and our institutions of higher learning were not the first to seek a solution for them in some form of election on the part of the student. It is almost exactly a hundred years ago that the English universities began to award honors upon examination in special subjects; for although the mathematical tripos at Cambridge was instituted sixty years earlier, the modern system of honor schools, which has stimulated a vast amount of competitive activity among undergraduates, may be said to date from the establishment of the examinations in Literis Humanioribus and in mathematics and physics at Oxford in 1807. The most popular of the subjects in which honors are awarded are not technical, that is, they are not intended primarily as part of a professional training; nor are they narrow in their scope; but they are in general confined to one field. In short they are designed to ensure that the candidate knows something well; that he has worked hard and intelligently on one subject until he has a substantial grounding in it.

For us this alone would not be enough, because our preparatory schools do not give the same training as the English, and because the whole structure of English society is very different from ours. American college students ought also to study a little of everything, for if not there is no certainty that they will be broadly cultivated, especially in view of the omnipresent impulse in the community driving them to devote their chief attention to the subjects bearing upon their future career. The wise policy for them would appear to be that of devoting a considerable portion of their time to some one subject, and taking in addition a number of general courses in wholly unrelated fields. But instruction that imparts a little knowledge of everything is more difficult to provide well than any other. To furnish it there ought to be in every considerable field a general course, designed to give to men who do not intend to pursue the subject farther a comprehension of its underlying principles or methods of thought; and this is by no means the same thing as an introductory course, although the two can often be effectively combined. A serious obstacle lies in the fact that many professors, who have reaped fame, prefer to teach advanced courses, and recoil from elementary instruction—an aversion inherited from the time when scholars of international reputation were called upon to waste their powers on the drudgery of drilling beginners. But while nothing can ever take the place of the great teacher, it is nevertheless true that almost any man possessed of the requisite knowledge can at least impart it to students who have already made notable progress in the subject; whereas effective instruction in fundamental principles requires men of mature mind who can see the forest over the tops of the trees. It demands unusual clearness of thought, force of statement and enthusiasm of expression. These qualities

have no necessary connection with creative imagination, but they are more common among men who have achieved some measure of success; and what is not less to the point, the students ascribe them more readily to a man whose position is recognized, than to a young instructor who has not yet won his spurs. Wherever possible, therefore, the general course ought to be under the charge of one of the leading men in the department, and his teaching ought to be supplemented by instruction, discussion and constant examination in smaller groups, conducted by younger men well equipped for their work. Such a policy brings the student, at the gateway of a subject, into contact with strong and ripe minds, while it saves the professor from needless drudgery. It has been pursued at Harvard for a number of years, but it can be carried out even more completely.

We have considered the intellectual relation of the students to one another and its bearing on the curriculum, but that is not the only side of college life. The social relations of the undergraduates among themselves are quite as important; and here again we may observe forces at work which tend to break up the old college solidarity. The boy comes here sometimes from a large school, with many friends, sometimes from a great distance almost alone. He is plunged at once into a life wholly strange to him, amid a crowd so large that he can not claim acquaintance with its members. Unless endowed with an uncommon temperament, he is liable to fall into a clique of associates with antecedents and characteristics similar to his own; or perhaps, if shy and unknown, he fails to make friends at all; and in either case he misses the broadening influence of contact with a great variety of other young men. Under such conditions the college itself comes short of its national mission of throwing together youths of promise of every kind from every part of the country. It will, no doubt, be argued that a university must reflect the state of the world about it; and that the tendency of the time is toward specialization of functions, and social segregation on the basis of wealth. But this is not wholly true, because there is happily in the country a tendency also toward social solidarity and social service. A still more conclusive answer is that one object of a university is to counteract, rather than copy the defects in the civilization of the day. Would a prevalence of spoils, favoritism or corruption in the politics of the country be a reason for their adoption by universities?

A large college ought to give its students a wide horizon, and it fails therein unless it mixes them together so thoroughly that the friendships they form are based on natural affinities, rather than similarity of origin. Now these ties are formed most rapidly at the threshold of college life, and the set in which a man shall move is mainly determined in his freshman year. It is obviously desirable, therefore, that the freshmen should be thrown together more than they are now.

Moreover, the change from the life of school to that of college is too abrupt at the present day. Taken gradually, liberty is a powerful stimulant; but taken suddenly in large doses, it is liable to act as an intoxicant or an opiate. No doubt every boy ought to learn to paddle his own canoe; but we do not begin the process by tossing him into a canoe, and setting him adrift in deep water, with a caution that he would do well to look for the paddle. Many a well-intentioned youth comes to college, enjoys innocently enough the pleasures of freedom for a season, but released from the discipline to which he has been accustomed, and looking on the examinations as remote, falls into indolent habits. Presently he finds himself on probation for neglect of

his studies. He has become submerged, and has a hard, perhaps unsuccessful, struggle to get his head above water. Of late years we have improved the diligence of freshmen by frequent tests; but this alone is not enough. In his luminous Phi Beta Kappa oration, delivered here three months ago, President Wilson dwelt upon the chasm that has opened between college studies and college life. The instructors believe that the object of the college is study, many students fancy that it is mainly enjoyment, and the confusion of aims breeds irretrievable waste of opportunity. The undergraduate should be led to feel from the moment of his arrival that college life is a serious and many-sided thing, whereof mental discipline is a vital part.

It would seem that all these difficulties could be much lessened if the freshmen were brought together in a group of dormitories and dining halls, under the comradeship of older men, who appreciated the possibilities of college life, and took a keen interest in their work and their pleasures. Such a plan would enable us also to recruit our students younger, for the present age of entrance here appears to be due less to the difficulty of preparing for the examination earlier, than to the nature of the life the freshman leads. Complaints of the age of graduation cause a pressure to reduce the length of the college course, and with it the standard of the college degree. There would seem to be no intrinsic reason that our school boys should be more backward than those of other civilized countries, any more than that our undergraduates should esteem excellence in scholarship less highly than do the men in English universities.

The last point is one that requires a word of comment, because it touches the most painful defect in the American college at the present time. President Pritchett has declared that "it is a serious indictment of the standards of any organization when the conditions within it are such that success in the things for which the organization stands no longer appeal effectively to the imaginations of those in it." We may add that, even in these days, indictment is sometimes followed by sentence and execution. No one will deny that in our colleges high scholarship is little admired now, either by the undergraduates or by the public. We do not make our students enjoy the sense of power that flows from mastery of a difficult subject, and on a higher plane we do not make them feel the romance of scholarly exploration. Every one follows the travels of a Columbus or a Livingston with a keen delight which researches in chemistry or biology rarely stir. The mass of mankind can, no doubt, comprehend more readily geographical than scientific discovery, but for the explorer himself it would be pitiful if the joy of the search depended on the number of spectators, rather than on zeal in his quest.

America has not yet contributed her share to scholarly creation, and the fault lies in part at the doors of our universities. They do not strive enough in the impressionable years of early manhood to stimulate intellectual appetite and ambition; nor do they foster productive scholarship enough among those members of their staffs who are capable thereof. Too often a professor of original power explains to docile pupils the process of mining intellectual gold, without seeking nuggets himself, or when found showing them to mankind. Productive scholarship is the shyest of all flowers. It cometh not with observation, and may not bloom even under the most careful nurture. American universities must do their utmost to cultivate it; by planting the best seed, letting the sun shine upon it, and taking care that in our land of rank growth it is not choked by the thorns of administrative routine.

If I have dwelt upon only a small part of the problems of the university; if I have said nothing of the professional and graduate schools, of the library, the observatory, the laboratories, the museums, the gardens, and the various forms of extension work, it is not because they are of less importance, but because the time is too short to take up more than two or three pressing questions of general interest. The university touches the community at many points, and as time goes on it ought to serve the public through ever increasing channels. But all its activities are more or less connected with, and most of them are based upon, the college. It is there that the character ought to be shaped, that aspirations ought to be formed, that citizens ought to be trained, and scholarly tastes implanted. If the mass of undergraduates could be brought to respect, nay, to admire, intellectual achievement on the part of their comrades, in at all the measure that they do athletic victory; if those among them of natural ability could be led to put forth their strength on the objects which the college is supposed to represent; the professional schools would find their tasks lightened, and their success enhanced. A greater solidarity in college, more earnestness of purpose and intellectual enthusiasm, would mean much for our nation. It is said that if the temperature of the ocean were raised the water would expand until the floods covered the dry land; and if we can increase the intellectual ambition of college students the whole face of our country will be changed. When the young men shall see visions the dreams of old men will come true.

INAUGURAL ADDRESS OF THE PRESIDENT OF DARTMOUTH COLLEGE[1]

THE past sixteen years have been and ever will be notable years in the history of Dartmouth College. In that time the number of students has all but quadrupled; and the material equipment of the college has expanded in proportion. The college has added to its libraries, built laboratories for its scientific departments and modern dormitories for its students. Its teaching staff has grown in size and advanced in quality. In every direction its growth has been rapid and great, but at the same time normal and balanced. The student body has changed in more ways than mere numbers, for if we believe with William Wyckham, "that manners maketh man" and to a very considerable extent they undoubtedly do, Dartmouth is not only graduating more, but a better average of men than in earlier times. Dartmouth's development in these years has been due in an extraordinary degree to the work of a single leader, and that leader is Doctor Tucker. His winning, alert and earnest personality, his wisdom, foresight and daring, his moral and physical energy, have carried the college forward over many obstacles which to others, at the time, seemed insuperable, and so they would have been under other leadership. The college has been truly blest with an intrepid and farsighted pilot, who has brought her safely over rough seas and through some narrow and dangerous channels. The college, the state and the nation have just reason to take pride in Doctor Tucker's great achievement.

That grave problems still face the college is but evidence that Dartmouth is thoroughly alive, for in death only are all problems solved. It is not, however, of Dartmouth's individual problems that I wish to speak to-day—I am not yet sure I know them all. I want rather to speak of some of the problems common to all our American colleges, and ask per-

[1] Given by Dr. Ernest Fox Nichols on October 14.

mission to speak of them not as an administrator, but as a college teacher—a calling in which I have some background of experience.

The college is the latest phase of the institutional life of our country to be assailed by the reformer, and it can not be denied that we have been unfortunate in some of those who have hurried in to tell us our faults. All angles of the complex problem are gradually coming into view, however, and the public once awake may be trusted to do its own thinking.

To open the whole subject in one address is manifestly impossible, yet there are some fundamental matters here which should be better understood. I shall speak briefly first of the place and intention of the college in our American education and later on certain aspects of the curriculum on undergraduate life and some of the problems of teaching.

The college rises on the finished foundations of the secondary school and leads to the professional and liberal departments of the university on the one hand and directly into the open fields and the branching highways of life on the other. It offers a quiet space for the broadening, deepening and enriching of the mind and soul of man, a home of mental industry and moral growth, a season for "the austere and serious girding of the loins of youth" and an inspiration to "that other life of refined pleasure and action in the open places of the world."

To those approaching graduate studies the college should offer those fundamental courses which serve as points of departure for the higher branches of theoretical and practical knowledge pursued in the university. To all it should give sound training in those analytical powers of reason upon which sane judgment must ever rely for its validity and it should offer that knowledge of economic, social and political problems essential to enlightened and effective citizenship. The college should aid its students to understand what man is to-day by filling in the background, physical, mental and spiritual, out of which he has come in obedience to law. The whole current of college life should be so directed as to foster the finer qualities of mind and spirit which give men dignity, poise and that deeper sense of honorable and unselfish devotion to the great and common good.

Whatever knowledge and trained faculties a student may have acquired at graduation depend more upon the man and less upon the college. Colleges may provide the richest opportunities and the fullest incentive, but that which lies beyond is work the student must do in himself. College, like life, is whatever the man has industry, ability and insight to make of it. "They also serve who only stand and wait" was written to console blindness and advancing years, not as an apology for strength and youth.

THE CURRICULUM

To attack the curriculum seems to be an easy and rather stimulating task for most reformers, but to grasp its whole significance and deal fairly by it require more thought and pains than many a magazine or newspaper writer is accustomed to give to the things he so often whimsically approves or condemns. To understand the recent history of our colleges, from any point of view, the intellectual development of the world during the past half century must be taken into account as well as the rather lagging response which has come from school and church to its widening demands.

The middle of the last century saw the beginning of several intellectual move-

ments. Natural science got under way earliest by establishing the doctrines of evolution and energy. The bearing of these broad principles soon became as necessary to our modes of thought as they were immediately recognized to be for our material development. To-day there is no branch of knowledge which has not in somewise been extended and enriched by the philosophical bearing of these wide sweeping laws which, at first, were the individual property of natural science. So intimately have they become the guiding principles of all modern constructive thinking, that steer how he will the man in college can not escape their teachings. Although these principles are still most significantly presented in the laboratories in which they arose, the student will as surely find their progeny in philosophy and history, in theology and law.

The progress of half a century in the social sciences (history, economics, sociology, politics), has been of equal importance. Though no such fundamental and far reaching doctrines as those of evolution and energy have there been discovered, yet social studies have become vital to the interpretation and upbuilding of modern life and service.

What response did our colleges make to this revolution in thought, this sudden widening of intellectual and spiritual horizons, this modern renaissance? For a time practically none, for the curriculum was strongly entrenched in an ancient usage. Something called a "liberal education" was a kind of learned creed. The intellectual atmosphere outside the college grew broader, stronger, freer than in it. Forced by a rising tide, the colleges first made a few grudging and half-hearted concessions, but still held for the most part firmly to their creed. The defenders could always point in unanswerable argument to the men of profound and varied talents who have been trained under their discipline—a discipline which all must freely admit has never been excelled. But times had changed, professional schools and real universities had come into existence in America, and more kinds of preparation were demanded of the college. Modern life in its vastly increased complexity had outgrown the straitened mould of a pedagogical and clerical curriculum.

Finally in an awakened consciousness some colleges made the mistake inevitable after too long waiting, and not only established the newer subjects in numerous courses, but took the headlong plunge and landed in an unbridled elective system.

Under this unhappy system, or lack of system, for every student who gains a distinct advantage by its license several of his less purposeful companions seek and find a path of least resistance, enjoy comfort and ease in following it, and emerge at the other end, four years older, but no more capable of service than when they entered. Many another youth neither lazy nor idle, but lacking both rudder and chart, angles diligently in shallow waters, goes no deeper than the introductory course in any department, comes out with many topics for conversation, but no real mental discipline and but little power to think.

During the revolutionary period in our colleges, in which the newer studies took equal place along side the older ones, Dartmouth moved more circumspectly than some of her neighbors. In response to pressure from within and from without required courses were reduced in number and crowded back into freshman year. All other courses were grouped in logical sequences among which the student had for

every useful purpose all the freedom afforded by what I have called the unbridled elective system; but obstacles and hazards which required some serious thought and discipline to surmount were strewn in the path of least resistance. The incomplete angler also was compelled in some places to go deep enough to get the flavor of several branches of learning and acquire some sort of discipline.

Under this so-called group system, which has taken many forms in different colleges, our education is become liberal in fact as well as in name (the newer studies may be followed for their own sake as well as the older ones), and the college horizon has been vastly widened. The older and newer knowledges now stand on a footing of complete equality of opportunity, our education has caught up with the time and is in harmony with modern needs. Moreover the framework of the present curriculum is elastic enough to easily adapt itself to any changed conditions which may later arise.

In all this readjustment, many advocates of the classics have, it seems to me, been somewhat unduly alarmed and have lost sight for the moment of some of the sources of greatest strength in classical learning. They have emphasized the discipline of classical studies too much, and their charm too little. The undergraduate of to-day will not shirk disciplinary studies if he can be made to see definitely whither they lead and that the end be one which appeals to his understanding and tastes. He refuses to elect courses which are only disciplinary or are so represented.

The classics are as truly humane to-day as they ever were. Scientific studies have exalted observation and reason, we are gaining a sudden and surprising insight into nature and into social problems. We have grown in constructive imagination and the power to think relentlessly straight forward, but the vision has been mainly external. Spiritual interpretations embodied in the nobler forms of artistic expression, in music, in poetry, in art, have not kept pace with our intellectual progress. It was in a genius for adequate, free and artistic expression, it was in imagination, in poetry, in consummate art and an exalted patriotism that the classic civilizations were strong. They had that in them to which man with a clearer insight and finer appreciation will one day gladly return. Their literatures give the fullest expression to the adolescence of the race, that golden time when men were boys grown tall, when life was plastic, had not yet hardened, nor men grown stern. Truth, beauty, goodness were still happily united; men did not seek them separately, nor follow one and slight the rest. Even philosophy with Plato was poetic in conception, and rarely smelt of the lamp.

Some of the deepest experiences of the race can not be justly characterized as either true or false because they have no place in the logical categories, hence unfeeling reason can not wholly find them out nor utterly destroy them. Much confusion and harm have come to man's most vital concerns through loss of balance and failure to recognize limits to pure reason as we now know it. Many a soul has been beaten back or shrunk by rejecting all impulses which could not be explained or fitted into some partial scheme of things. In this both science and theology, in different ways, have at times offended. Both with an assumed authority have marred the spirit by attempting to crowd it into the frame of a procrustean logic or to square it with a too rigid dogma. That this was neither true science nor good theology is now becoming clear, bound-

aries are shifting and the thought of man is moving forward toward the freedom of his birthright. No education which does not arouse some subtler promptings, vague aspirations—"Thoughts hardly to be packed into a narrow act, fancies that break through language and escape"—can rightly interpret the real and deeper sources of human action and progress. Our present emphasis is warped and partial, education should be an epitome of the whole of life, not of a part of it.

The tendencies of our college life, whatever some may say, are neither irreligious nor immoral, but quite the contrary. Religion is a side of the student which the present formal curriculum does not touch directly, hence for completeness' sake, some broad and effective religious teaching should be provided. Yet just how can such instruction be given in a way to hit the mark and not invade an instinctive sense of individual privilege? There is no realm of teaching which is more intimately personal and private than that which deals with religious convictions, and nowhere is the likelihood of good and ill result more dishearteningly tangled. Certainly such instruction in college could not be in the slightest degree dogmatic, and any special pleading would as surely defeat the intention. If courses broadly cast could be offered, in which the simple purpose was an impartial and sympathetic enquiry into the highest teachings of the several great religions with emphasis laid on the ethical and social import of various beliefs, Christian doctrine would inevitably rest on a broader foundation and be seen plainly of all men to justify its place in history. It is in a comparative study of religious teachings that I firmly believe Christianity will soonest achieve its rightful and vital supremacy in the minds of college men. Such studies can but add fresh reasons for our faith.

As our colleges give courses in the classics and esthetics, so they offer ethical courses, and some add a course in the philosophy of religion to their program of studies. Yet for some reason, possibly because the instruction is not simple and concrete enough, possibly the human side is treated too contemptuously, whatever the reason may be, courses in morality and religion are not now fulfilling their purpose because too few students elect them. To make such courses compulsory would be instantly to defeat their high purpose, and yet, somehow, the appeal of the college must be made to transcend the too narrowly intellectual side of man. Esthetics, ethics and religion are supremely rich in human interest; surely then courses of increased attractiveness somehow can be fashioned which students will more freely choose to their larger growth and lasting benefit. When this is done, and then only, shall we enlighten the whole man. His heritage in the deeper life will then no longer be left wholly to "time and chance which happeneth to them all."

Before entering upon a discussion of that most interesting and many sided person, the undergraduate, may I in behalf of true science, in which I am deeply interested, add a warning? Scientific studies just now are beset with some of the dangers of an unenlightened popularity. The public has lately taken a wide but too often untutored interest in natural science. A just appreciation of the enormous difficulties which fundamental investigation encounters is rare, and the limitations of our present methods of analysis are little understood outside the walls of the research laboratory and the mathematician's study. The blazonings of the latest scientific achievements in newspaper and magazine, too frequently immature and incorrect, with emphasis all awry, are building up a quite unreasoning expectation in the

minds of credulous readers. The study of science may do for the student other and better things than those he anticipates, yet many will be inevitably disappointed at the problems which the study of science will not solve. Enthusiastic parents, heedless of taste and fitness, too often urge their sons into scientific pursuits, not realizing that lack of intellectual preference in a boy is inadequate proof that he possesses that balanced mind which scientific investigation requires, and unusual pleasure at riding in an electric car is insufficient evidence of a marked capacity for the broader problems of electrical engineering. May not science be spared by some of her too enthusiastic publishers and over credulous admirers, who urge popular and sensational courses in science in place of the fundamental instruction now given? How much longer must newspapers and magazines give money and valuable space for worse than useless matter only because it masquerades in the garb of science?

UNDERGRADUATE LIFE

From every point of view the undergraduate is the central figure of the college. Clever or dull, industrious or lazy, serious or trifling, he is the only apology the college has to offer for its life. Him our restless critics would give no peace and he takes a gentle vengeance upon his accusers by being unconscious of them. All their thrusts are lost on him, at whose shortcomings they are mainly directed, for the real miscreant rarely reads.

The reformer's indictment is much too long to discuss here in detail, but he has discovered, for instance, that the average young man in college does not care enough for knowledge to pay proper attention to his studies. But this is not new, the average student never has. Again he finds that too many young men in college drift into a life of ease and indolence. But this is as true out of college as in, and worse, it is a failing by no means confined to the young. To the stress of modern athletics, he claims the average student contributes not his muscle but only a voice. Yet in the earlier days before athletics, which a few of us remember, some men in college were even voiceless. A very slow growth, well rooted in a time-honored past, of indifference to scholarship on the part of some students seems to him a deadly fungus which has sprung up over night, an evil which requires some immediate and drastic remedy if the college is to survive, and he chafes at our tolerance and slowness to act.

An unhappy requisite for any thoroughgoing dissection is that death must precede it. Thus many a recent thrust at the college is directed at conditions belonging to a past existence. An even greater weakness of the critical faculty, in our day, is an intemperance which loses all sense of proportion and puts things too strongly—a weakness into which even those in the highest places have sometimes fallen. Thus evils which occur in the few receive a stress and lack of measure which seem to attach them to the many. In the practise of the newer criticism "the exception proves the rule" in an unfamiliar sense.

What class of students in college, it may reasonably be asked, cause us most concern? Certainly not the capable and energetic men who earnestly seek knowledge. Such do not even require very skilful teachers in the pedagogical sense, for given the necessary facilities they teach themselves most things. Some guidance from scholarly men they need, and little else. The dull but hard working student, though less independent, knows quite well how to care for himself and becomes educated in doing so. The real difficulty comes with

the indifferent, idle, ambitionless man who often, by reason of native capacity or sound early training, easily makes the passing mark which technically puts him beyond the reach of formal discipline and he tempts envious chance no further. This man is no stranger to us, he has always been in college, but we have come recently to take more notice of him. He oftener comes of well-to-do parents who also may look upon college as a polite formality in a young man's life. But too much emphasis must not be put on money, for the sons of the rich are not all idle nor, alas, are the sons of the poor always industrious. To take an extreme case, he is a man lacking in ideals, or equipped with an unprofitable set. He often comes to college avowedly despising books and their contents. He longs only to study men, to build those life-long friendships which brighten later years, and he too often hears much to encourage this attitude at home. How then does this youth go about so serious a business as the study of men? By closely observing the more earnest among his teachers and his fellow students who are using their college opportunities to fit themselves for life? No. But rather by seeking companions as passive as himself and drifting in the same sluggish current. I have no wish to give this wretched man more discussion than his flaccid and misguided purposes deserve, yet as critics have made much of him and greatly magnified his numbers, surely we should give his weakened state a thorough-going diagnosis that the treatment may be carefully chosen and salutary.

For this class of men home influence, or the lack of it, is more often to blame than the college. It is an open question whether the college has any obligation to help a small group of men who care so little to help themselves. In the English system the answer frankly given is that the college has none. The pass and poll men of Oxford and Cambridge are present examples of a lifeless indifference to earnest scholarship in which the university has acquiesced. In England, however the indifferent are separated from the working students and are never a drag on their betters. In this country the numbers of this extreme type in most colleges are, as yet, small, but the range between it and the real student is long, and young men who are learning less than they might are scattered all the way between. The problem is not new, but it perplexes us and disturbs our counsels exceedingly. It is difficult to conduct a college which shall be at once an effective training school for studious men and an infirmary for the treatment of mental apathy. If it is our duty to keep such men in college, and many think it is, the problem presented is how to wake them up, and a pertinent question arises—are we at present organized to get at them by the only open door? Do we often enough get at the center of the man through his false ideals and the husks of his intellectual sloth? Can our teaching be made more direct and personal, not in a meddling way, but by methods vigorous and manly? In most colleges this problem has been complicated by numbers. The staff of teachers is not as large as it should be, and the human side of teaching, which requires the closest contact as well as breadth and sanity in the teacher, is in danger. That flint and steel contact between teacher and pupil, which many have reason to remember from the classrooms of their day, is now less frequent. The spark we have seen start mental fires in many an indifferent mind is struck less often. The hope of closer personal attention to students in college is in larger endowments which will sustain a more numerous teaching staff and permit classes to be further subdivided according

to scholarly ambition. This is a change which few colleges can now afford to make, for colleges must do with the means they have and keep within their incomes, if they can.

As to how this much discussed decline in scholarship, the real existence of which I seriously doubt, has come about, there are widely different opinions. In the first place, it may be justly questioned whether it is not apparent rather than real. The average student acquires more and wider knowledge in college now than he did thirty years ago. Outspoken scholarly enthusiasm rather than the getting of lessons seems to have suffered. Many students appear to have relaxed a little in the seriousness of purpose with which they approach their work. They certainly show more reserve in the way they speak of it. Here it must be remembered, however, that fashions the country over have changed and the expression of interest and enthusiasm in some subjects is more stintingly measured than a generation ago. If anything we now often get a scant portion in expression where we used to get an over-weight. Nowhere is this change more striking than in the gentle art of public speaking. Yet fashions react on men and our time may have lost something in forcefulness from its often assumed attitude of intellectual weariness, from a painstaking effort at restraint and simplicity of utterance. Our present tendency is to speak on the lighter aspects of even grave matters—possibly a kind of revolt against a flowery sentimentalism, an unctuous cant, or a long face. It is not considered in the best of taste just now to get into heated discussions and controversies over man's most vital intellectual and spiritual concerns.

The habit of suppression has come into the college from without. I do not think it began there. Science in the university may have misled the thoughtless to some extent by an emotionless discussion of facts, but facts should be discussed without emotion; it is the lifeless statement of purpose from which we suffer. The driving power of intellect is enthusiasm, and there is no lack of it in that passionate devotion to research which so painstakingly and properly excludes all warmth from its calm statement of results. Yet it is nothing short of a divine zeal, an irresistible force, which urges the true investigator on to those great achievements, which are so profoundly changing the habits of our daily life and thought. For any mental indifference, therefore, be it real or assumed, science is in no wise responsible. Science takes herself very seriously and is always in deadly earnest.

In only one phase of college life to-day may a student, other than shamefacedly, show a full measure of pleasurable excitement, and that is in athletics. What might not happen to him who threw up his hat and cheered himself hoarse over a theorem of algebra, or over the scholarly achievements of the faculty! Some young men appear to have grown shy and to feel that a show of enthusiasm over ideas reveals either doubtful breeding, a lack of balance, or small experience with the world. They would be like Solomon in saying "there is no new thing under the sun," and profoundly unlike him in everything else—an easy apathy to things of the mind and spirit so often passes for poise and wisdom with the young! Thus some indifference in college and out of it is undoubtedly more assumed than genuine. But again we are in danger of utterance and manner reacting on thought and effort. Signs of such a reaction are already apparent. Thus the college atmosphere has seemingly lost, for the initially weak in character, some of its vigorous and wholesome mental incentive.

May we not henceforth live our college

life on a somewhat higher plane, where real simplicity, naturalness and downright sincerity replace all traces of sophistication and wrong ideals. Let genuine enthusiasm find freer and more fearless expression, that we may become more manly, strong and free. Why can't some college men stop masquerading in an assumed mental apathy and be spontaneously honest?

Some who have sought an explanation of this slightly altered tone in college life blame intercollegiate athletics for the changed conditions, but I am not able to find the cause there, and believe, as I have already suggested, that it lies far deeper in the changed conditions of society and our national life. The outcry to abolish intercollegiate sports is rather hard to explain. Aside from the assumed injury done to studious habits, apparently no one really objects to sports kept within bounds. But our colleges by agreement may set the bounds wherever they choose. Where, then, is the real reason for complaint? On the other hand, intercollegiate sports do more to unite the whole college and give it a sense of solidarity than any other undergraduate activity, and thus serve a worthy purpose. Moreover, the lessons of sport are lessons of life and it is the moral worth rather than the physical benefit of athletics which we can ill afford to lose from student life. They effectively teach a high degree of self control, concentrated attention, prompt and vigorous action, instant and unswerving obedience to orders, and a discipline in accepting without protest a close ruling, even if a wrong one, in the generous belief that he who made it acted in good faith. Sport, like faith, knows no court of appeal. A man's moral fiber comes out in his bearing toward his opponent in the stress of play and in the dignity with which he meets defeat or victory at the end of the game. By gallant conduct toward a victorious adversary a bodily defeat becomes a personal triumph. It is only when the spirit is defeated through the body that upright men cry shame! I believe one of the severest tests of a gentleman to be his ability to take victory, or defeat, with equal good will and courtesy toward those against whom he has bodily contended. Whether we get all that we might out of our college sports is another question, but year by year we approach nearer and nearer to the higher standards of a true sportsmanship.

The problem of athletics suggests another problem which is its twin: What shall we do for the symmetrical development of those who do not train on college teams but who need physical training far more than athletes do? Here is a question which has not been successfully met and one which demands immediate and wider consideration than it has yet received.

To strengthen interest in scholarship by introducing a larger element of competition than at present is a suggestion which has come from several different sources recently. The competitive idea has long been in full force in the older English universities with what is now regarded there as a result to which good and evil have contributed nearly equal parts. Our own colleges have always offered some prizes for high scholarly attainment but the inspiration for a sufficient extension of the custom to make it a leading idea in our undergraduate life has been drawn from the extraordinary success of athletic contests in arousing student effort and enthusiasm. That a wider competition in scholarship than we now have would produce some useful results lies beyond question, but that those who expect most of all things from it will be disappointed may be confidently predicted. It seems to me that the larger part of the ardor students show for athletic contests is due more to the appeal which bodily combat always makes to the dramatic sense than to the competitive idea in

itself. It is the manly struggle more than the victory which men go out to see. I can not conceive how we are to clothe scholarship contests with a dramatic setting—as well attempt to stage the book of Job, aptly called "the drama of the inner life." The drama of scholarship must ever be a drama of the inner life which will never draw a cheering multitude nor light bonfires. To call men to witness a contest in geometry is less strong in its appeal to human sympathies and interest than the bootless cries of Diogenes prostrated at the roadside, to those who passed on their way to the Olympic games. "Base souls," he cried, "will ye not remain? To see the overthrow and combat of athletes how great a way ye journey to Olympia, and have ye no will to see a combat between a man and a fever?" Competition is a fundamental law of nature, and it may be a human instinct, but it never can be an ideal, for the virtue of an ideal is a willingness for self-sacrifice of some sort, while the virtue of competition is a willingness to sacrifice others. Competition, therefore, is not a moral force, and as a motive lacks the highest driving power.

Most that I have said of undergraduate life has been in analysis of its weakest members. The vast majority of college men are sound in mind and heart and purpose and no young men were ever worthier of admiration and respect than these. I have not dwelt upon them because their condition suggests no vexed pedagogical nor administrative problems. "They that be whole need not a physician, but they that are sick."

THE TEACHER

As with the undergraduate, so with the faculty, many a reformer has singled out the weakest member and has seemingly affixed this label to all. But has he forgotten that there are mediocre lawyers, physicians, preachers, engineers, business men, all making a living from their various occupations simply because there are not enough men of first-rate ability to supply the world's needs? Teaching can not stand alone but must share the lot of other professions. In a generation the monetary rewards in most occupations have advanced more rapidly than in teaching, where they never have been adequate, and colleges have felt a relative loss. In law, in engineering, in medicine, in business, the average rewards for corresponding successes are roughly double those in teaching. It is safe to say the colleges are getting far more out of their better teachers than they are paying for. Teaching is to many a very attractive career, not because of the leisure for idleness which it is supposed by some to offer but because of its possibilities of service to the wholesome life and highest welfare of society and the state. The teacher who takes his calling seriously and fulfils its high demands spends less time in idleness than his apparently more busy brethren in trade. That he must give many hours to wide-ranging thought and reflection has often misled the public into thinking him an idle dreamer. But dreaming and visions are a part of his business, though the dreamer to be worthy must dream straight and the vision must be clear. How much do we not owe to the dreamer, in science, in literature, in art, in religion, to say nothing of his part in those unthought of benefits, those subtler influences grown up in tradition, influences which have lost or never had a name, which yet continue to inspire and brighten all our days—visions seen by earlier men whose lives must have seemed idle enough to an auctioneer?

Judged by the higher standards, there are unquestionably a few uncertain and indifferent teachers in our colleges. There always have been. The proportion of men

of first-rate ability has improved, but there is need of further improvement. As soon as the public will give the colleges sufficient means to command the men they want, all cause for criticism will be removed.

We need special knowledge in college teachers, but not specialized men. Whatever the subject, it is the whole man that teaches. While being taught the undergraduate observes the teacher and takes his measure in several well-defined directions: the richness of his knowledge, his enthusiasm for learning, his way of putting things, his sense of humor and the range of his interests. He shrewdly guesses whether or not his instructor would be an agreeable companion, if all restraints were removed, and the subject of the day's lesson swept out of mind. The student frequently knows, too, whether or not his instructors are producing scholarly work which competent students elsewhere admire and respect. Nothing gives a teacher more authority and command over the imaginations of his students than a well-earned reputation for fundamental scholarship and research, and nothing so much stimulates the undergraduate's ambition for sound learning and intellectual achievement as sitting at the feet of a master who has traveled the road to discovery. Even as much as a virtuous example breeds virtue in others, so scholarly work breeds scholarship. Presidents and boards of trustees have not always seen the great advantage to a college of retaining a group of strong productive scholars with an instinct for teaching, on its faculty. All these elements enter into the unconscious respect the student feels for his instructor, and increase or lessen a teacher's influence and worth in the college. The driving of men through college is not as reputable as it used to be, and real intellectual and moral leadership in teaching is steadily taking its place. Students now largely choose their courses and instructors, for varying reasons to be sure, but some of them are good. Student opinion freed from mixed motive and superficial judgment is usually wholesome and sound.

The college in all its relations is the most human and humanizing influence in all our civilization; and year by year its gains in this direction are substantial. Taking the good with the bad our colleges have never been as well organized and equipped as now, nor have they ever done their work more effectively than they are doing it to-day. Any dissatisfaction with college life does not find its basis in comparisons with earlier years, notwithstanding many find, in such comparisons, partial reason for complaint. We are not quite satisfied with the college, because it does not realize our later ideals of education, not because it falls short of our earlier ones. It is well to have ideals and to have them high, and it is a wholesome sign of intellectual vigor to be impatient at the long distance which separates the way things are done from the way we think they ought to be done. Beyond just measure, however, dissatisfaction paralyzes hopefulness and effort; we must keep clear of pessimism, if we are to go forward.

In twenty years of teaching and observation, I have become convinced of some things connected with teaching as a profession. No teacher can hope to inspire and lead young men to a level of aspiration above that on which he himself lives and does his work. Young men may reach higher levels but not by his aid. The man in whose mind truth has become formal and passive ought not to teach. What youth needs to see is knowledge in action, moving forward toward some worthy end. In nobody's mind should it be possible to confuse intellectual with ineffectual. Let it not be said:

We teach and teach
Until like drumming pedagogues we lose
The thought that what we teach has higher ends
Than being taught and learned.

It ought to be impossible, even in satire, to say "Those who can, do; those who can't, teach."

The strong teacher must ever have the best of the priest about him in the fervor of his faith in the healing power of truth. Let our teaching be sane, fearless and enthusiastic, and let us not, even in moments of despondency, forget the dignity, the opportunity, the power of our calling. The teacher is the foremost servant of society and the state, for he is moulding their future leaders. Sound learning, wisdom and morality are the foundation of all order and progress, and these it is the aim of the college to foster. If we can send into the world a yet larger number of strong young men—men clean in body, clean in mind and large of soul, men as capable of moral as of mental leadership, men with large thoughts beyond selfishness, ideas of leisure beyond idleness, men quick to see the difference between humor and coarseness in a jest—if we can ever and in increasing numbers send out young men of this sort, we need never fear the question —"Can a young man afford the four best years of his life to go to college?"

DR. WILLIAM WIGHTMAN

IN SCIENCE of June 4 last there appeared the following brief item:

"Dr. William Wightman, of the Public Health and Marine Hospital Service, died at Guayaquil, Ecuador, on May 17, from yellow fever."

As a rule, only the claim of conspicuous achievement can arrest any wide attention at the passing of a unit of the race; yet the circumstances of the life and death of William Wightman merit an attention wider than the circle of his acquaintances, and may offer some inspiration for all who labor for the betterment of the race.

It is a subject of common, if rather vague, remark that America is beginning to exert a wider influence on the welfare of other peoples of the world, especially on that of our less favored sister nations of the same continent. This influence is constantly wielded through diplomatic efforts, through the labors of educational or religious bodies, through the movements of commercial expansion, but in no way more certainly and more beneficially than through the striking achievements and the example of our medical profession. The sanitary measures employed at Panama and extended to points of the west coast of South America for the better protection of the Canal Zone, have been of such evident advantage as to win a hearty recognition and an effort of cooperation from the South American countries. The indirect results in these countries will form a significant chapter in history, even though the names should be forgotten of those who labored at the beginning. Nevertheless, the foundation of an achievement of which the nation will be justly proud is laid by those who do the pioneer work under circumstances which demand not only a high degree of determination, but rare patience, tact and honor, or even an unassuming heroism. Of such pioneers was William Wightman, an American by adoption, by affection and by devoted service.

In the early part of 1906, as a young surgeon in the Public Health and Marine Hospital Service, who had served efficiently on our western coast, Dr. William Wightman was detailed to Callao, Peru, to act as quarantine agent attached to the American Consulate. For two years he served his country at this port, manifesting not only professional ability, but inflexible devotion to his duties, and unfailing courtesy and tact. It is not too much to say that he won the respect, and even the affectionate esteem, of most of those whose private interests suffered from the rigid measures of disinfection. Certainly he held a high place in the affection of the American and English residents and visitors of that region,

while he gained the confidence of the Peruvian surgeons and other officials with whom he was brought into contact. Undoubtedly, his presence, his sympathy and his counsel gave aid and inspiration to the native officers who labored for the cause of good health.

In the spring of 1908, when the government of Ecuador undertook the monumental task of eradicating the bubonic plague and yellow fever from its chief port, the city of Guayaquil, Dr. Lloyd, then in the quarantine service of our government at that city, was chosen by the Ecuadorian authorities to direct the difficult campaign of sanitation. This led to the removal of Wightman from Callao to Guayaquil to have charge of the important quarantine work at that place.

In Ecuador, even more than in Peru, Wightman was not content with the mere performance of official duties, but gave himself to professional service according as the need arose and so far as his limited spare time permitted, contending with the diseases of smallpox, bubonic plague and yellow fever. It was in such professional activity that he contracted the disease which so sadly terminated his short career.

There is no wish to attach an undue glamor of heroism to a simple and conscientious service. A principal charm and virtue of Wightman's was the mobility of his temperament, the ease with which he adapted himself to persons and conditions. While contributing to the health and pleasure of those about him, he found a sincere enjoyment, not only in his professional duties, but in the best society, native and foreign, that his surroundings afforded. There was no discontentment, no evident sacrifice. Only the closest friends could gain an intimation of the real sacrifice entailed by the enforced separation from a loved wife and child, whom he feared to take into an unhealthful climate, or by the exposure of a constitution of whose weakness he was aware to so prolonged a stay in a tropical region. It was these considerations, and chiefly the former, which made his transfer to Guayaquil a reluctant one, though accepted without complaint. The personal exposure to infectious diseases was, of course, accepted unreservedly as the lot of his profession.

The sacrifice involved in such a case is the greater from the fact that our government, strangely, offers no assurance or hope of a just provision for the families of those who may risk and give their lives in such patriotic and humanitarian service.

A life devoted steadfastly to the country of his adoption, and finally sacrificed all too early by the voluntary extension of this service for the good of fellow men of another nationality —in this is an appeal to the pride of all Americans. A wide and sincere sympathy will be felt for the wife and child that are bereft.

We pride ourselves that the American flag goes out over the world as the emblem of peace, of health and of prosperity, but the men who most loyally carry it and who, unknowingly, add to its honor are such as William Wightman.

Robert E. Coker

THE HARPSWELL LABORATORY

The Harpswell Laboratory at South Harpswell, Maine, was opened for the tenth season from June 10 to September 9, 1909, every room being occupied by investigators. No considerable changes have been made in the equipment, but the library has been increased, chiefly by gifts of separata from authors. Of these there are over 500 new titles, while friends kindly gave subscriptions to several American journals. To all these the thanks of the laboratory are due.

The following persons worked at the laboratory, most of them for the entire season:

George A. Bates, professor of histology, Tufts Medical School. Histology of the teeth.

Frank S. Collins, Malden, Mass. Studying the marine Algæ of Casco Bay.

Ulric Dahlgren, professor of biology, Princeton University. Comparative histology of various vertebrates and invertebrates.

Charles H. Danforth, instructor in anatomy, Washington University, St. Louis. Structure of the head in a recently hatched *Amiurus*.

Pauline H. Dederer, tutor in zoology, Barnard College. Pressure experiments on developing eggs of *Cerebratulus* and spermatogenesis in *Platysamia*.

C. W. Hargitt, professor of zoology, Syracuse University. Embryology of the cœlenterates.

George T. Hargitt. Embryology of *Clava* and *Aurelia*.

J. S. Kingsley, professor of biology, Tufts College. Comparative anatomy of vertebrates.

Frederic S. Lee, professor of physiology, Columbia University, and Max Morse, instructor in natural history, College of the City of New York. The phenomena of summation of stimuli in various invertebrates.

Charles S. Mead, instructor in zoology, Northwestern University. Structure of Verrill's "*Dinophilus simplex*."

T. H. Morgan, professor of zoology, Columbia University. The effects of centrifuging the eggs of *Cerebratulus*.

H. V. Neal, professor of biology, Knox College. The histogenesis of the eye muscle nerves in *Acanthias*.

Harley J. Van Cleave, graduate student in the University of Illinois. The cell lineage of *Cerebratulus*.

Leonard W. Williams, instructor in comparative anatomy, Harvard Medical School. The anatomy of *Myxine*.

During the summer seminars were held weekly, with extra meetings several times. At these times members of the laboratory and visitors presented the results of their recent work or made statements of the condition and progress of their special fields. Among these talks were the following:

Frank S. Collins: "Certain Problems in the Geographical Distribution of the Marine Algæ."

Ulric Dahlgren: "The Development of the Electric Organs in the African Genus *Gymnotus*."

Bashford Dean: "The Embryology of the Lower Fishes and its Bearing on the Validity of the Biogenetic Law."

Herbert S. Jennings: "Recent Experiments on the Causes and Meanings of Conjugation in *Paramœcium*."

J. S. Kingsley: "Recent Evidence Bearing on the Origin of Mammals."

F. D. Lambert: "The Life History of an Undescribed Genus of Chlamydomonads."

Frederic S. Lee: "The Phenomena and Causes of Fatigue."

F. B. Loomis: "Fossil Hunting in Sioux County Nebraska."

C. S. Mead: "The Chondrocranium of the Pig."

Charles S. Minot: "Recent Researches on the Morphology of the Blood."

T. H. Morgan: "Heredity of Hair Color in White Mice."

Max Morse: "Rhythmical Pulsations in the Umbrella of *Aurelia* and *Cyanea*. The Determination of Sex."

Leonard W. Williams: "The Primitive Segmentation of the Mesoderm and the Origin of the Sclerotomes in the Chick."

Frederick A. Woods: "The Evidence Bearing on the Question of Modifications as the Results of External Conditions."

HONORARY DOCTORATES CONFERRED BY HARVARD UNIVERSITY

On the occasion of the inauguration of Dr. A. Lawrence Lowell as president of Harvard University, honorary degrees were conferred on thirty delegates. Those on whom the degree of doctor of science were conferred and the characterizations of President Lowell were as follows:

William Napier Shaw, eminent in the new science of meteorology; welcome delegate from John Harvard's college, and from the ancient university whose sons bore the sacred fire of learning to a new England.

John Christopher Willis, also a delegate from the University of Cambridge; an eminent botanist, remarkable for his knowledge of tropical vegetation; director of the Royal Garden in Ceylon; who has done a great work in improving the varieties useful to men.

John Harvard Biles, delegate from the University of Glasgow; professor and master of naval architecture on the Clyde, where fleets are built that carry the commerce of the world.

Hector Frederick Estrup Jungersen, delegate from the University of Copenhagen; professor of zoology and director of the Zoological Museum; heir of an ancient and virile race, who has enriched modern science by his profound studies of reproduction and development in fishes.

George Alexander Gibson, delegate from the University of Edinburgh; physician and professor of medicine; a clear and prolific writer; investigator of the action of the heart; distinguished teacher in a school long famous, where founders of our own medical school were trained more than a hundred years ago.

Jacobus Cornelius Kapteyn, director of the Observatory of Groningen; astronomer and organizer of scientific work; fit representative of a strong race, already glorious in arms, in art, in learning and in adventure.

WILLIAM ABBOTT HERDMAN, delegate from the University of Liverpool; a great authority on marine biology, who has dredged the floor of the ocean, and learned the secrets of the oyster and the pearl.

WILLIAM BERRYMAN SCOTT, a delegate from Princeton University; a persistent and thorough explorer of early mammal forms, he has helped to draw aside the veil that shrouds the mystery of life upon our planet.

ARTHUR AMOS NOYES, chemist of renown; a leader of research in physical chemistry. As professor at the Massachusetts Institute of Technology, and recently its head, our neighbor, our fellow-laborer, and our friend.

EDWARD BRADFORD TITCHENER, a delegate from Cornell; thorough and exact in methods of work in a new and rich field, his researches in experimental psychology have enlarged the bounds of human knowledge.

ELIHU THOMSON, delegate from the American Academy of Arts and Sciences; prolific in research and invention; a magician who by the witchcraft of science has subdued electricity to the service of man.

The degree of doctor of law was conferred on President Remsen with the following words:

IRA REMSEN, president of Johns Hopkins University; eminent for his researches in chemistry; a public-spirited citizen; and worthy to lead the university that first taught our country the higher training of scholars.

SCIENTIFIC NOTES AND NEWS

PROFESSOR GEORG LUNGE, the eminent chemist of Zurich, was presented on September 19 with a gold medal bearing his portrait and the sum of 40,000 francs to celebrate his seventieth birthday and the jubilee of his doctorate. Chemists were present from many countries and addresses were delivered by a number of delegates. Professor Lunge in his reply announced his intention of giving the money to the Polytechnic Institute for the aid of students of chemistry.

WE learn from *Nature* that in view of the retirement of Professor J. Cleland, F.R.S., from the chair of anatomy, and of Professor Jack from the chair of mathematics, at the end of the present month, there has been set on foot, on the initiative of the business committee of the general council of the University of Glasgow, a movement for making appropriate recognition of their long and distinguished services. The form of recognition will, to a large extent, depend on the amounts subscribed, but it is thought that it might fitly include the provision of some fund for the advancement of anatomical and anthropological science in the case of Professor Cleland, and of mathematical science in the case of Professor Jack, and the presentation to the university of portraits or busts by an eminent artist.

DR. J. F. ANDERSON has been appointed director of the Hygienic Laboratory, Washington, D. C., to succeed Dr. M. J. Rosenau, who retires from the Public Health Service to accept a professorship of preventive medicine and hygiene at Harvard University. Dr. Anderson entered the Public Health Service in 1898 and for the past seven years has been assistant director of the laboratory. He has carried on his work on the standardization of diphtheria and tetanus antitoxins, market milks for tubercle bacilli and immunity and anaphylaxis. He is a graduate of the University of Virginia.

DR. KARL SCHWARZSCHILD, professor of astronomy at Göttingen, has been appointed director of the Astrophysical Observatory at Pottsdam.

DR. O. L. ZUR STRASSEN, associate professor of zoology at Leipzig, has been appointed director of the Museum of the Senckenberg Natural History Society at Frankfort.

TEMPORARY INDUSTRIAL FELLOWSHIP, No. 7, at the University of Kansas, concerning the relation of the optical properties of glass to its chemical constitution, has been awarded to E. Ward Tillotson, Ph.D., of Yale. Dr. Tillotson, while at Yale, held both the Loomis and the Silliman fellowships in chemistry.

WM. A. WITHERS, professor of chemistry in the North Carolina College of Agriculture and Mechanic Arts and chemist of the Experiment Station, was elected president of the Association of Official Agricultural Chemists at its

recent meeting in Denver, August 26 to 28, 1909.

Some anxiety is caused by the failure to receive news from Professor C. K. Leith, of the University of Wisconsin, who, with Mr. Hugh M. Roberts and Mr. Francis S. Adams, has been making geological explorations in the neighborhood of Hudson Bay. No word has been received from them since their departure last June, and it is thought that they may be compelled to spend the winter in the north.

Professor A. S. Hitchcock, systematic agrostologist of the U. S. Department of Agriculture, has returned to Washington after four months spent in Alaska and the Yukon District studying the grasses of the region. The greater part of the work was done in the valley of the Yukon. Large collections representing the rich grass flora of the country were made for the National Herbarium.

Mr. Carlos Guerrero, of the Argentine Republic, is visiting this country to study agricultural methods.

Dr. John C. Willis, director of the Royal Botanic Gardens of Ceylon, will give a course of four lectures on "Tropical Agriculture, with Special Reference to Economic Problems," at Harvard University, on October 12, 14, 16 and 19.

Dr. W. B. Cannon, professor of physiology in the Harvard School, lectured before the Middletown Scientific Association on October 12, his subject being "Digestive Processes and the Influence of the Emotions upon Them."

Dr. Charles R. Barnes, professor of plant physiology at the University of Chicago, lectures before the Geographical Society of Chicago on October 15, on "Mexican Plants and People."

The subject of Professor Osler's address at the London School of Tropical Medicine, which is to be delivered on October 28, is "The Nation and the Tropics."

At University College, London, public introductory lectures were given by Sir William Ramsay, on "Radium Emanation: one of the Argon Lines of Gases," and by Professor J. A. Fleming, on "Electrical Inventions and the Training of Electrical Engineers."

Washington Irving Stringham, A.B. (Harvard '77), Ph.D. (Johns Hopkins '80), professor of mathematics in the University of California since 1882, appointed acting-president of the university during the president's leave of absence, died on October 5, at the age of fifty-two years.

Leonard Pearson, M.D., since 1891 professor of veterinary medicine in the University of Pennsylvania, and since 1897 dean of the veterinary school, known for his work on tuberculosis among cattle, died on September 20 at the age of forty-one years.

Professor Anton Dohrn, whose death we were compelled to announce last week, died at Munich, on September 26. He was sixty-eight years of age. The funeral, after cremation, took place at Jena on October 3.

At the meeting of the Chemists' Club, New York, held on October 8, it was announced that a Chemists' Building Company had been organized, for the purpose of acquiring a plot of ground, 56 $\times$ 100, at 50 East 41st Street, and erecting thereon a large scientific building, the lower floors of which are to be rented to the Chemists' Club on a long lease, and contain scientific meeting rooms, a library and a museum, as well as the ordinary facilities required by a social organization, including sleeping apartments for its members. The upper floors of the building are to be rented for scientific laboratories for commercial and research work in chemistry and allied sciences. For the past eleven years the Chemists' Club has been located at 108 West 55th Street, and various chemical societies have used its meeting room, which has gradually proved inadequate to meet the growth of these organizations.

At the closing meeting of the International Geodetic Association, held at Cambridge, there were made several announcements of scientific interest. According to the report in the London *Times* Lieutenant-Colonel Burrard, representing India, said that recent levelling operations in India showed that the Siwalik range gained a few centimeters in

height in the great earthquake of 1905. Geologists believed that the whole mass of the Himalayas and Tibet was being pushed south and wrinkling up a new range out of the alluvial plain. The survey authorities had recently laid down six lines of bench marks which would be observed every ten years. Mr. B. F. E. Keeling, representing the Survey of Egypt, announced that the Egyptian government had recently purchased a platinum iridium standard from the same batch as the international meters, which would be the standard of length for Egypt; and that they hoped to begin gravity observations next spring with the pendulums belonging to the South Kensington Museum which Captain Scott took to the Antarctic. Mr. W. F. King, presenting the report from Canada, announced that his government had recently decided in favor of making the main triangulation of Canada not merely sufficient for topographical purposes, but of the highest possible accuracy, and that the department would henceforth be known as the Geodetic Survey of Canada. Mr. Nakano (Japan) described methods by which he had been successful in determining differences of longitude by the use of wireless telegraphy. Professor Foerster (Berlin) announced that the Bureau of Weights and Measures at Breteuil would shortly undertake a definite comparison between the stability of wires and of tapes of Suvar. M. Poincaré announced that arrangements had been made to send a signal each day at noon by wireless telegraphy from the Eiffel Tower. This signal will be available for shipping in the Atlantic and the Mediterranean, for the determination of longitude. Dr. Helmert (chief of the Central Bureau) announced the program of work of the Central Bureau for the next three years. It included further researches on the variation of latitude, deviations of the vertical along the 48th parallel, new reduction of the observations of gravity over the ocean, a general comparison of observations of latitude and deviation of vertical throughout the world, and a continuation of the observation of lunar earth tides. Sir George Darwin, presenting the report of the Rigidity of the Earth Commission, asked the association to adopt a resolution approving of the grant of £100 annually to enable observations to be made by Dr. Hecher's method in the deep silver mines of Przbram, in Hungary, and asking the cooperation of the International Seismological Association.

Harlan I. Smith, of the department of anthropology of the American Museum of Natural History, has returned from a three months' trip along the northwest coast of America from Seattle to Skagway. He resumed his archeological reconnoissance of the coast, carrying it northward from Alert Bay near the northern end of Vancouver Island to a point on the Chilkat River, about twenty-five miles above Haines. The following sites were located: an ancient village site about four miles above the mouth of the Bella Coola River; shell heaps in the vicinity of Old Matlankatla and Prince Rupert, and both north and south of Port Simpson; a village site at the old eulichon fishing ground on the north side of Nass River a few miles above Kincolith; petroglyphs near Wrangel, and several village sites along the Chilkat River, between Haines and Klukwan. Over three hundred photographs, of which one hundred ninety-two were on $6\frac{1}{2} \times 8\frac{1}{2}$ plates, were taken to show as completely as possible all the phases of Indian life met with on the trip at Victoria, North Saanich, Alert Bay, Rivers Inlet, Bella Coola, Port Simpson, along Nass River, at Wrangel and along the Stickine, Iskut and Chilkat Rivers. Photographic prints illustrating ethnological conditions were also purchased wherever possible. Among the ethnological objects seen the few not already represented in the museum collection were purchased. Two Bella Coola totem poles were secured in order that they may be preserved as ethnological specimens and may lend artistic effect to the Northwest Coast Hall in the museum. Arrangements were made to secure other poles from the various areas of the northwest coast culture for the same purpose. Mr. Will S. Taylor, a mural artist, the other member of the expedition, made color studies in oil of the

Indians and their artificial and natural environments. These with the aid of the photographs secured on the expedition and those already in the museum are to be used for mural decorations in the Northwest Coast Hall. These it is hoped will illustrate the home country of the seven groups of natives together with their characteristic occupations.

THE Philadelphia College of Pharmacy announces special lectures to be held from October to April, inclusive, at 3:30 P.M., in accordance with the following schedule:

Friday, October 8—"Examination of Foods," by Dr. W. D. Bigelow, Chief, Division of Foods, U. S. Department of Agriculture, Washington, D. C.

Friday, October 22—"The Application of the Microscope in Legal Investigations," by George M. Beringer, A.M., Ph.M., Pharmacist and Chemist, Camden, N. J.

Thursday, November 4—"American Medicinal Plants and Drugs," by Professor John Uri Lloyd, Manufacturing Pharmacist, Cincinnati, O.

Friday, November 19—"The Typhoid Organism and its Relation to the Public Health," by Dr. A. C. Abbott, Director Laboratory of Hygiene, University of Pennsylvania.

Friday, December 10—"The Manufacture and Testing of Medicinal Plasters," by F. B. Kilmer, Chemist for Johnson & Johnson, New Brunswick, N. J.

Friday, December 17—"Trypanosomes and Trypanosomiases (The Sleeping-Disease and its Causes)," by Dr. Leonard G. Rowntree, Instructor in Pharmacology and Experimental Therapeutics, Johns Hopkins University.

Friday, January 7—"Plants Injurious to Animals," by Dr. Rodney H. True, Physiologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

Friday, January 21—"Physiological Assay, Its Value and Limitations," by Professor H. C. Wood, Jr., Department of Pharmacology, University of Pennsylvania.

Friday, February 11—"The Ultra-microscope and its Application," by Jerome Alexander, Secretary-Treasurer National Gum and Mica Company.

Friday, February 25—"Some of the Important Tests for Essential Oils," by Dr. Francis D. Dodge, Chemist, Oil Distilling Laboratory, Dodge & Olcott, Bayonne, N. J.

Friday, March 11—"The Testing of Cements," by Richard K. Meade, B.S., Director Meade Testing Laboratories, Nazareth, Pa.

Thursday, March 24—"Biologic Products," by Dr. S. H. Gilliland, President, Dr. H. M. Alexander & Co., Marietta, Pa.

Friday, April 8—"Modern Methods of Food Manufacture," by L. S. Dow, of the Heinz Preserving Company, Pennsylvania.

Friday, April 22—"State Control of Contagious and Infectious Diseases," by Dr. Samuel G. Dixon, Commissioner of Health of Pennsylvania.

THE *British Medical Journal* states that the natural history department of the British Museum has received a cast of the fossil human lower jaw found recently some seventy feet below the surface in a sand deposit at Mauer, near Heidelberg. It was found along with fossil remains of a rhinoceros and elephant, similar to those met with in the Cromer forest beds, and Dr. Shoetensack, who has published a description of the jaw, considers that it may be referred to the later pleistocene epoch. The discovery of this "Heidelberg man," therefore, takes the antiquity of the human race back to an age earlier than the famous Spy and Neanderthal skulls. The jaw is massive, and has no chin, in which respects it presents ape-like characters, but the teeth are distinctly human; the molars have five cusps, the canines are not specially prominent, and the dimensions of the teeth generally are within the limits of variation at the present day. The skull is exhibited in a case which contains also casts of *Pithecanthropus erectus* from Java, the Neanderthal skull, the Gibraltar skull of the same type, the Spy skull and limb bones, the Cannstadt skull, and the Tilbury skull described by Owen.

THE *Journal* of the American Medical Association says: Several statues of prominent members of the profession in Europe have been installed recently as memorials at the scene of their labors, but the designs of the sculptors have all been ornately allegorical, and many criticisms have been made that this conflicts with the simplicity and love of absolute truth which distinguishes the scientists thus honored. The Brouardel statue at Paris is a bust of the scientist on a tall pedestal with two

graceful female figures below, forensic medicine and hygiene, a little smaller in proportion than the bust, lifting high a garland to wreath it at the base of the bust. It stands in the grounds of the medical school. The Mikulicz memorial at the surgical clinic at Breslau represents in bas relief Mikulicz seated in profile, while two standing female figures, medicine and science, of a size rather dwarfing the recipient, are placing the wreath of immortality on his brow. One can not help imagining that Mikulicz feels rather embarrassed at the situation. The Kussmaul memorial is a bust rather larger than life-size hewn out of the stone forming the base of the memorial, with a smaller allegorical bas relief below of medicine relieving a sick youth. The allegorical design has run riot in the Virchow statue, which is to be merely a statue of Hercules overcoming the Nemean lion, representing Virchow's conquest of disease. There is nothing to suggest Virchow personally except a small bas relief bust below. Something like the simple grandeur and life-like presentation of a St. Gauden's statue of Lincoln is what the friends of the scientists long for as a much more appropriate tribute to the memory of men of science, perpetuating their personality, but the sculptors, as a rule, seem determined to insist on decorative allegorical designs.

The government is now carrying on work at regular forest experiment stations similar to the agricultural experiment stations in the different states. The first forest experiment station created in this country was the Coconino Experiment Station at Flagstaff, Arizona, established last summer. Investigations covering many phases of forestry in the southwest have already been undertaken at this station. The second forest experiment station has been established this year on Pike's Peak, Colorado. The need for such stations becomes apparent when the long time necessary for handling forest experiments is considered. In agricultural experiments definite results can usually be obtained in one or at most a few years; in forestry, because of the long time required for trees to develop, scores of years are often required to complete a single experiment. All experimental work is conducted under the direction of men who have had training in technical and practical forestry, and every experiment is intended to have a direct bearing upon some problem which vitally concerns the management of the forest. Under this system any new plan can be thoroughly tried before being put into practise on a large scale, and thus the injury resulting from mistaken practises can be minimized. The greatest technical problem which now confronts the forester in handling the great pine forests of Arizona and New Mexico is that of establishing a new stand of trees to replace the old timber which is cut off. This was the first problem undertaken by the Coconino Experiment Station. Much information regarding the factors influencing natural reproduction has already been secured, but many years of systematic study will be required to fully solve the problem. The feasibility of artificial regeneration by planting and sowing is also being tested. The latter experiments, for the sake of economy, are being conducted on the smallest scale which will insure reliable results applicable to general conditions. The plans for the near future provide for a detailed study of the problems concerning the natural and artificial regeneration of other commercial trees such as Douglas fir, Engelmann spruce and the junipers.

Some account of the work of the Hamburg Expedition to the Pacific is given in *Globus* and summarized in the *Geographical Magazine*. Its principal field of operations has been the little-known island of New Britain (New Pomerania), the first crossing of which, in its full width, has been effected by the expedition. As mentioned in a previous note, the expedition, which is under the leadership of Dr. Fülleborn, has the benefit of a vessel specially chartered for the purpose, and its work has been greatly facilitated thereby. A preliminary cruise along the north coast of the island showed that the eastern district—that of Nakanai—which has not been supposed to extend further west than Open Bay, in reality extends for more than half the length of the north

coast, being followed, further west, by those of Talasea and Bariai, in which the influence of New Guinea culture is much more manifest. Owing to the exposure of the north coast to the northwest monsoon during the early months of the year, it was decided to begin serious work on the south coast, which was followed from east to west, a large number of coast villages being visited, and some communication opened with the very primitive dwellers in the back country. The observations permit the definition of several distinct culture regions on this coast. Artificial deformation of the skull was found to be practised, especially between Montague Harbor and Cape Pedder. The voyage extended to the New Guinea coast (where a key was found to various facts in the ethnology of western New Britain), and a visit was paid to Sir George Rooke or Umbai Island. Returning, a landing was effected at the mouth of the Pulie River, whence a trade route leads across to the north coast, and this was utilized for the crossing of the island by Dr. Fülleborn and two of his European companions, who afterwards returned by the same route. The crossing occupied seven days, and the country was found to be covered with a uniform thin forest, broken only by the extensive plantations of the natives. The health of several members of the expedition has unfortunately suffered a good deal.

UNIVERSITY AND EDUCATIONAL NEWS

Yale University has received from Mr. William D. Sloane and Mr. Henry T. Sloane the sum of $475,000 to build, equip and endow a physical laboratory. This laboratory, it is understood, will replace the present Sloane Physical Laboratory, and will be used by the academic, the scientific and the graduate departments. Yale University has also received $25,000 from Mr. Alfred G. Vanderbilt for general endowment, and $15,000 from Mr. G. H. Meyers for the endowment of the Forest School, of which he is an alumnus.

Columbia University has received gifts amounting to about $236,000, of which $112,500 is from Mr. W. H. Charpentier, to be added to the J. S. Charpentier fund, and $100,000 is given anonymously toward the cost of Kent Hall.

The Pratt Institute of Brooklyn has received the sum of $1,750,000 from Mr. Charles M. Pratt, son of the founder and now its president, and from his five brothers and his sister, Mrs. E. B. Dane.

Dr. D. K. Pearsons has offered to give $100,000 to Berea College, provided that the sum of $400,000 is otherwise subscribed.

Mr. N. B. Duke has made a further gift of $50,000 to Trinity College at Durham, N. C.

It is reported that the Free University of Brussels has received an anonymous gift of 4,000,000 francs for its scientific departments.

Dr. George E. Fisher, professor of mathematics in the University of Pennsylvania, has been appointed dean of the college.

At the University of Nebraska, Professor Robert H. Wolcott has been made professor of zoology and acting dean of the College of Medicine as successor of Henry B. Ward, who has gone to the University of Illinois.

Professor Gustave F. Wittig, of the electrical engineering department of the University of Maine, has resigned to become head of the electrical engineering department of the University of Alabama.

Dr. Byron B. Brackett has been appointed to the chair of electrical engineering at the South Dakota State College. He has held the chair of electrical engineering at the Clarkson School of Technology since 1903.

At Harvard University, Dr. Edwin Katzenellenbogen has been appointed lecturer in abnormal psychology, W. J. Risley, A.M., instructor in mathematics, and A. V. Kidder, A.B., Austin teaching fellow in anthropology.

Dr. H. B. Kribs has been promoted to an instructorship of zoology at the University of Pennsylvania and Dr. H. M. Jacobs to a similar position in the place of Philip P. Calvert, who is on leave of absence. In the same department Dr. Harold Colton has been appointed assistant.

The following appointments have been made in the chemical department of the

North Carolina College of Agriculture and Mechanic Arts, for the year 1909–10: Dr. L. F. Williams promoted from an instructorship to an assistant professorship; Burton J. Ray, A.B. (Wake Forest, Ph.D., Cornell), instructor in organic chemistry and assistant chemist in the Experiment Station; Frank W. Sherwood, B.S. (North Carolina A. & M.), assistant chemist in the Experiment Station.

Reginald E. Hore, of Toronto, formerly instructor in the University of Michigan and in Queens University, has been appointed instructor in petrography in the Michigan College of Mines, Houghton.

Dr. E. B. Hutchins, Ph.D. (Wisconsin), has resigned the professorship of chemistry at Carroll College to accept the position of manager of a manufacturing establishment in Fond du Lac, Wis. S. B. Hopkins, Ph.D. (Johns Hopkins), has been elected to the position at Carroll College.

Dr. A. H. Gibson has been elected professor of engineering at University College, Dundee, to succeed Professor Fidler, who has resigned.

Professor H. Kossel, director of the hygienic institute at Giessen, has received a call to Heidelberg. His brother, Dr. A. Kossel, is professor of physiology at Heidelberg.

Dr. F. Hartmann, of the Astrophysical Observatory at Pottsdam, has been appointed professor of astronomy at Göttingen and director of the observatory.

DISCUSSION AND CORRESPONDENCE

NATURE STUDY

To the Editor of Science: In the advertisement of a new book on "Nature Study" I find the following statement:

> There is a great deal of talk about nature study by persons who have only the haziest idea of what they mean by it.

With this I am in cordial agreement. Why the term "nature study" should be appropriated as applying to that partial range of the phenomena of the physical universe which is the particular province of the biologist I have never been able to see. I believe that the word φύσις is the equivalent of the Latin *natura,* for which the English is *nature.* The derivation of the word physics is apparent. The old term "natural philosophy" is an excellent one, sanctioned by the best use from Newton to Thomson and Tait, and serving as a contrast to "natural history" or the purely descriptive part of that science of nature which does without philosophy. The term physics is shorter and belongs to other languages than English, and it seems to me that if the biologists desire a correspondingly convenient term it is for them to invent one, and not to preempt the whole of nature, which is greater than any part.

Arthur Gordon Webster

NEON AND ELECTRIC WAVES

To the Editor of Science: Professor J. Norman Collie, F.R.S., recently discovered that when perfectly pure neon is enclosed in a glass tube with a globule of mercury and shaken, it glows with a bright orange-red color, and when the globule rolls it appears to be followed by a flame. This phenomenon takes place at ordinary pressure.

Sir William Ramsay has found that neon is the best conducting of the gases and that it readily becomes luminous under the influence of electric waves. Professor J. A. Fleming, F.R.S., uses a neon tube as a detector for the wave-length of Hertzian waves in his apparatus for measuring them.

During a recent visit to Sir William Ramsay I had the pleasure of seeing the astonishing quantity of over 500 c.c. of pure neon which he had obtained from about 120 tons of air. While there, Professor Collie very kindly presented to me a tube of neon, under about one half an atmosphere pressure, containing a globule of mercury which showed the "Collie effect" very strikingly.

Returning from Liverpool, July 2, on the steamer *Baltic,* I was given opportunity during the voyage, by Mr. Bates, the chief operator of the wireless, to try the neon tube as an instrument for the visual reading of the wireless message. We experimented with it during two nights and found that the neon glowed beautifully in response to the waves sent out,

but the waves as received were too weak to visibly affect the neon, although we tried every arrangement of the limited apparatus at our command. The electric wave sent out by the *Baltic's* apparatus was, according to Mr. Bates about 800 feet long.

WM. L. DUDLEY

VANDERBILT UNIVERSITY

FUNDULUS LUCIÆ AGAIN IN NEW JERSEY

ON July 28, 1909, I secured a single small example of this species in a little inlet, which empties into Barnegat Bay several miles below Seaside Park, on Island Beach in Ocean County. The inlet was well choked up with grass, so that the water was perfectly still and formed a little brackish pond. Only multitudes of *Cyprinodon variegatus* and many young *Fundulus majalis* were found associated. I mention this record simply as it is the most northern at which *Fundulus luciæ* is known to occur.

HENRY W. FOWLER

ACADEMY OF NATURAL SCIENCES,
PHILADELPHIA, PA.

THE BURDEN OF NOMENCLATURE

THE scientific white man's burden is largely one of names and no one knows better than the zoologist how great the incubus has become. Names in boundless profusion are heaped upon him—many of them needless synonyms—and, worst of all, no two zoologists can agree upon any one particular name for any one particular genus or species. The efforts of individuals, of committees and of conventions to enforce agreement according to rule have failed and it is not surprising that widespread disgust prevails because of the nomenclatural confusion which exists. No code of rules yet devised for the purpose of fixing a single name on each entity has proved adequate to check the changes which go merrily on year after year. In fact zoological nomenclature to-day seems to be little more than an intricate game of names, fascinating sport for its faithful devotees, but an intolerable nuisance for the uninitiated many! A few specialists interested in the game have made all the rules and done all the playing, and they are directly responsible for the changes. Nothing has been let alone long enough to become stable, not even the codes.

One of the principal reasons why codes fail is because individual opinion interprets them. Conventions bark up the wrong tree—it is not rules for "eliminating" genera that are needed so much as rules for eliminating individual opinion. The zoologist consumer would seem to be in the clutches of a word-trust that furnishes him not with what he needs but with what he can get according to canon X, Y or Z; and we all know what a fertile field for the exploitation of rules and canons ornithology has been. In the latest code of nomenclature—that published by the American Ornithologists' Union in July, 1908—the same ponderous machinery constructed in 1842 is made to do duty. The wheels and cogs have been repaired and repolished several times during the intervening years but as a machine for grinding out stable names it has proved signally inadequate. A check-list of North American birds issued in 1886 has already been revised and corrected, according to code, in no less than fifteen supplements and the end is not in sight. This is but a sample of the instability to be found in all branches of zoology.

Now, as a matter of fact, unpractical zoologists have long put up with a nuisance that business men would not have tolerated a moment. Practical business men settled telegraphic nomenclature, for instance, by publishing a code of over a thousand million pronounceable words with at least two letters difference between them, and surely zoological nomenclature, with but a small fraction of that number of names, should not be a hopeless proposition. We all know how many things are standardized—even the languages of France and of Spain. If a national academy sets the standard for language, are zoologists unable to establish a standard for zoological language by an international academy of their own? Something of this sort is urgently needed, for nomenclature is an art and not a science. Codes do not evolve but are made for convenience and we should quit bowing down to precedent and burning incense before the shrine of priority if we seek stability. Priority is rather a bog from which

the nomenclatural muck-rakers exhume the fossil names of a past age. We shall always be at the mercy of forgotten names tucked away in stray volumes unless there be some "statutes of limitation"—the bugbears of code makers. Let the upturning of the names of obscure writers be stopped and the remodelling of codes with fresh interpretations of their canons be prevented. It is not justice for the dead zoologist that we need so much as justice for the living, and even now the dead get no recognition if they violate the rules of a game unknown in their day. The "statute of limitation" needed at the point where codes break down is a responsible body of men whose rulings will be respected by every scientific man who cares more for stability in names than he does for his own preferences.

In my opinion, the nomenclature of the future is likely to be eclectic and the names fiat, the final court of appeal being an international committee. Such a committee, with the flood of evidence available nowadays, could soon put an end to all the tiresome quibblings over the fixing of generic types, the preoccupation of names, the spelling of words and all the other academic questions over which the most spirited disputes have arisen. It should publish authoritative lists of genera and species; for zoologists want names as handles for use, not toys to be played with according to this rule or that canon. If zoological names are ever to be put on a stable basis, first of all a stable committee is needed—and it is to be hoped the Nomenclatural Commission of the International Zoological Congress may prove to be such a committee—and then it should publish lists that would spike the canon of priority and obliterate individual opinion. Details may not be worked out in a day, but the thing can be done and once done it would not have to be done again unless nomenclature should evolve into something very different from what it now is. Probably zoologists have followed beaten paths too long to allow of any radical changes in the methods of determining names, but it is little short of ridiculous to bicker over the comparatively few names that rules do not fix. It is for these names that a majority vote of a committee is needed. Subcommittees in the different branches of zoology could furnish the international committee with approved lists of names for final revision and publication, and the zoological world should turn its back upon others than those of the international list. In theory, at least, the cure for nomenclatural instability is very simple and the two essential elements for success are a permanent, working committee and funds for publication. We should be the masters not the slaves of codes, remembering that "zoological nomenclature is a means, not an end, of zoological science."

Jonathan Dwight, Jr.

SCIENTIFIC BOOKS

A HALF CENTURY OF DARWINISM [1]

Of the many gatherings, large and small, to commemorate the hundredth anniversary of the birth of Charles Darwin, or the fiftieth anniversary of the "Origin of Species," the two most notable were the one held at Baltimore in January, and the one held at Cambridge in June of the present year.

At the Baltimore meeting, ten addresses were spoken, all relating to the lines of progress in our knowledge of evolution, and the relation of Darwin to this knowledge.

In connection with the meeting at Cambridge, essays were presented covering the relation of our knowledge of evolution to various phases of modern thought.

Except in brevity, the two volumes in question are essentially similar. The same motive is present in both. At Baltimore, all the speakers save one were American. At Cam-

[1] "Darwin and Modern Science," essays in commemoration of the centenary of the birth of Charles Darwin, and of the fiftieth anniversary of the publication of the "Origin of Species." Edited by A. C. Seward, Cambridge University Press (twenty-nine essays).

"Fifty Years of Darwinism," "Modern Aspects of Evolution," centennial addresses in honor of Charles Darwin, before the American Association for the Advancement of Science, Baltimore, Friday, January 1, 1909. New York, Henry Holt & Company (ten addresses, with an introductory chapter).

bridge, eleven were British, two American, six German, one French, one Danish and one Dutch. But this is merely an incident. Science takes no cognizance of state or racial boundaries, nor of sex, for it is only in passing that we need notice that one of the English essayists is a woman.

Among characteristics of these essays and addresses as a whole, we may note the broad tolerance and friendly tone shown by all the writers, without exception. All recognize the intellectual supremacy of Darwin, although most of them have made some addition, large or small, to the mass of fact and theory gathered by the master. Each one is gently insistent on his own point of view. We may compare Darwin to an explorer of a great region, to whom fell the making of the first map. While in many ways details have been added to this map, not much of the original scheme has been altered or taken away. While many shrill voices from time to time have been raised in criticism of one feature or another of "Darwinism," yet the common sense of the body of biologists has steadily maintained the integrity of the original chart. Natural selection very likely is not "allmächtig." Darwin never claimed that it was. But it is potent for all that, and the other factors in evolution work with it, and not in place of it. The scheme of the evolution of species, through variation and heredity on the one hand, and the selective influence of the environment on the other, has not greatly changed since the date of the "Origin of Species." The method, degree and to some extent the causes of variation, have been critically and successfully studied. The meaning and the machinery of heredity have been the subject of most fruitful investigation and experiment. Natural selection has been subjected to the most searching analysis, and the fact that its effects vary under varying conditions has been clearly brought out. But it still remains the only general cause of the universal phenomena of adaptation of life to environment. Isolation has been separated from selection as a factor theoretically distinct, but practically coexistent. The supposed Lamarckian factors have disappeared, to reappear again in unknown and perhaps unknowable forms. Theories of elemental species, unit characters and the like, have arisen to meet the facts and guesses involved in the investigations of mutation and the rediscovery of Mendelism, taking their place alongside of Darwin's bold hypothesis of pangenesis, and, like pangenesis, to pass away when the hypotheses are no longer needed. With all this, on the whole, the scheme of organic evolution, as presented in the "Origin of Species," still holds as an outline. The work of fifty years has intensified the main features of the sketch, and has constantly added to the work of the master, without obliteration of any essential details.

The instruments of precision in biological research have taught us many things. They have shown a physical basis of heredity, and by this means have made a theory of heredity possible. Scientific experiment has added many details, as to the development of cells, as to the behavior of hybrids, as to the processes of selection, as to the effects, direct and indirect, of many sorts of environments. Embryology has shown the method of development of each type of animal and plant. Our knowledge of extinct forms has grown by leaps and bounds. Even the lower ancestors of man have appeared in the rocks and in the forms the great morphologists have expected them to assume. Systematic geologists have gathered together the lessons of morphology, embryology and paleontology, to be applied to the construction of ancestral trees, while our knowledge of geographical zoology and botany has kept pace with the most rapid increase of knowledge in any other field. With all this, the entire face of philosophy, social science and even of theology, has been altered by the idea of descent, with modification, through natural causes, the most noteworthy being that of the survival of the fittest in the varied conditions of life.

In the American volume, Professor Thomas C. Chamberlin contributes the introductory chapter on the continuation of the Darwin impetus, admitting, if necessary, that "if the atom shall show an authenticated pedigree," it will "take its place in the procession of the

derived, with the plant, the animal, the earth and the stars." Professor Edward B. Poulton discusses the progress of biology in the "Fifty Years of Darwinism." Professor John M. Coulter discusses natural selection from the standpoint of the botanist, with an ingenious treatment of the "non-adaptive adaptations" that natural selection does not readily explain. Professor David S. Jordan discusses isolation as a factor in species making, taking the ground, as stated by Dr. Ortmann, that "the four factors, variation, inheritance, selection and separation (isolation) must work together to form different species. It is impossible that one of these should be by itself, or that one could be left aside."

The cell, in relation to heredity and evolution, is discussed as by one having authority, by Professor Edmund B. Wilson. Professor D. T. MacDougal speaks of the "Direct Influence of Environment"; Professor W. E. Castle of "The Behavior of Unit Characters in Heredity." Professor Charles B. Davenport treats of "Mutation," finding "certain evident elements of truth" in the speculations arising from the experiments of de Vries. Dr. Carl H. Eigenmann discusses "Adaptations," recognizing the fact stated by Weismann, that they "arise whenever needed if they are possible," considering the question of their origin as "the problem of problems," and giving to the whole a suggestion of a "Lamarckian" trend.

Professor Henry F. Osborn discusses Darwin and paleontology, with a leaning toward orthogenesis, a theory which needs only to be defined to receive general acceptance. Evolution and psychology are treated by Professor G. Stanley Hall, who finds that the psychic powers of man are but "new dispensations" of those of the lower animals, and that the debt of psychology to Darwinism is not one whit less than that of zoology or botany. Without the idea of descent through natural processes, all biological sciences are without meaning.

The Cambridge volume covers a wider range of subjects, including the influence of Darwinism on astronomy, philology, philosophy and theology, which last subject is taken more seriously in England than in America.

The veteran botanist, Sir Joseph Dalton Hooker, furnishes an introductory letter to the editor, Professor A. C. Seward. Professor J. Arthur Thomson discusses Darwin's predecessors and their relation to evolution. Professor August Weismann discusses the selection theory, which is fundamental to "Weismannism," as to Darwinism. Professor Hugo de Vries discusses variation from a point of view of experimental botany. "Heredity and Variation in Modern Lights" are treated by Professor W. Bateson. In this able essay is a footnote on "the isolation of the systematists" as "the one most melancholy sequela of Darwinism." "Should there not be something disquieting in the fact that among the workers who come most in contact with specific differences are to be found the only men who have failed to be persuaded of the unreality of these differences?" This strikes the writer as not at all just. Those systematic workers worthy of the name, in all countries, were among the first converts of Darwin. Not that Darwin's arguments persuaded them, but that their own studies showed that species can not be permanently separated as categories from races and varieties. But to the systematists is entrusted the bookkeeping of zoology and botany. Without the rules and the minute discriminations of taxonomy, all biological science would be lost in a maze. However impertinent the distinction between a variety and a species, a difference is a difference, and each term represents a degree of variation which has become hereditary and relatively permanent, and hence to be discriminated by those who deal with the details of organic being, from individual variation, and from alterations due to mutation or environment. The supposition that systematic zoologists and botanists are essentially dullards who do not know what is going on outside, and do not know what species are, is one frequently made by theorists or experimenters, who do not appreciate the methods of precision necessary in this particular field.

Systematists are not deceived in the matter of the despised species of British brambles but it is as legitimate and it may be as fruit-

ful a study to work out the effects of isolation, hybridization and climate on brambles as to test the effects of various alkaline salts on the eggs of a starfish. Good work counts, whatever its subject matter.

Professor Edward Strassburger discusses the "Minute Structure of Cells in Relation to Heredity," claiming with Darwin that "invisible gemmules are the carriers of hereditary characters, and that they multiply by division." This hypothesis he implies might have been developed by Darwin, had not his genius been "confined by finite boundaries by the state of science in his day." The "Descent of Man" is discussed by Professor G. Schwalbe. In this regard, he considers that Darwin's work is unsurpassed. "The more we immerse ourselves in the study of the structural relationship between apes and man, the more is our path illumined by the clear light radiating from him."

Professor Ernst Haeckel treats of "Darwin as an Anthropologist," in like sympathetic fashion.

Mr. J. G. Frazer discusses "Primitive Theories of the Origin of Man." Professor Adam Sedgwick discusses the "Influence of Darwin on the Study of Animal Embryology." Professor W. B. Scott treats of the "Paleontological Record as Regards Animals," and Mr. D. H. Scott, as regards plants. Professor George Klebs treats of the "Influence of Environment on the Forms of Plants," and Professor Jacques Loeb on the "Experimental Study of the Influence of Environment on Animals." Professor Edward B. Poulton emphasizes the value of color in the struggle of life. Sir William Thistleton Dyer treats of the "Geographical Distribution of Plants," and Dr. Hans Gadow of the "Geographical Distribution of Animals." Mr. J. W. Judd discusses "Darwin and Geology," and Mr. Francis Darwin, "Darwin on the Movement of Plants." Professor K. Goebel has an essay on the "Biology of Flowers," Professor C. Lloyd Morgan one on "Mental Factors in Evolution," and Professor Harald Höffding one on the "Influence of the Conception of Evolution on Modern Philosophy." Professor C. Bouglé discusses "Darwinism and Sociology," Rev. P. N. Waggett, the "Influence of Darwin on Religious Thought." This influence Mr. Waggett finds "from a Christian point of view, satisfactory," as all movements toward truth ought to be. It may be an "advance of theology" when theologians retreat. Mr. Waggett thinks that a "bolder theism" is now needed, and now justified.

Dr. Jane Ellen Harrison treats of the "Influences of Darwinism on the Study of Religions." The scientific study of religions begins with the Darwinian conceptions. Dr. P. Giles discusses "Evolution and the Science of Language." Professor J. Bury writes luminously on "Darwinism and History"; Sir George Darwin on the "Genesis of Double Stars," and Mr. W. C. D. Whetham has the final essay on the "Evolution of Matter." He doubts whether such cases of atomic disintegration as we now know can be characterized as "Evolution," and the question whether primeval matter was more or less complex, or both, than the matter of to-day, is still unsettled.

Through all these essays and addresses runs the vein of veneration for Darwin the man. The words used by the present writer in 1882, he still finds pertinent:

> Darwin lies in Westminster Abbey, by the side of Isaac Newton, one of the noblest of the long line of men of science whose lives have made his own life possible. For every truth that is won for humanity takes the life of a man. Among all who have written or spoken of Darwin since he died, by no one has an unkind word been said. His was a gentle, patient and reverent spirit, and by his life has not only science, but our conception of Christianity, been advanced and ennobled.

David Starr Jordan

THE FAUNA OF CHILE

Professor Carlos E. Porter, C.M.Z.S., director of the Natural History Museum of Valparaiso and of the "Revista Chilena de Historia Natural," is about to publish the first volume of a new work which bears the title of "Fauna de Chile," being a methodical and descriptive catalogue of the animals living in the Republic of Chile.

This work has been in preparation for a

number of years and the volumes II. to X. (large octavo) are to be published as soon as the manuscript of each is finished, with the assistance of numerous European and American specialists. This work, being thus brought up to date according to modern standards, will be indispensable to all museums and libraries of natural history.

Volume I. will contain the mammalia, by Mr. John A. Wolffsohn, C.M.Z.S., with numerous original illustrations in black and colored plates and photo-engravings in the text.

M. J. R.

NOTE ON THE OCCURRENCE OF HUMAN REMAINS IN CALIFORNIAN CAVES

In the course of an investigation of some of the limestone caverns in California during the last four years, a number of cases have been noted in which human remains were found in such situations as to indicate that their entombment was not of historically recent date. In no instance have any specimens been discovered which can be said to be of Quaternary age, although some of the occurrences are of such nature that it would be difficult to prove that the remains were buried during the present period.

The writer has already called attention[1] to the occurrence of human remains in Mercer's Cave in Calaveras County, and in the Stone Man Cave in Shasta County, under conditions which certainly suggest a considerable antiquity. In Mercer's Cave a number of human skeletal remains were found in close proximity to the bones of a Quaternary ground-sloth. The bones of both sloth and man were incrusted with a deposit of stalagmite, the incrustation on the sloth bones being considerably thicker than that on the human remains; and it is not probable that they were buried at the same time. It is, however, true that stalagmite deposits may be very uneven, and it is possible that the covering on the ground-sloth was formed in a shorter time than the thinner layer on the human bones.

The remains in Stone Man Cave were discovered in a remote gallery of this extensive cavern. The greater number of the bones were embedded in a layer of stalagmite which enveloped them to the thickness of one eighth of an inch or more. A vertebra which was obtained many years ago from this locality is found to have lost most of the organic material, and the cavities are largely filled with calcite crystals.

In neither of the cases just described is it possible to fix the age of the remains, but the impression given in both instances is that some centuries have elapsed since the skeletons came into the position in which they were found.

Another interesting occurrence of human bones has recently been brought to the notice of the writer by Dr. J. C. Hawver, of Auburn, California. During the past few years Dr. Hawver has engaged in an energetic exploration of the limestone caves in the vicinity of Auburn, partially at the instance of the University of California, but largely on his own resources. Hawver Cave, discovered by him and recently named in his honor, has been explored and described by Mr. E. L. Furlong,[2] but Dr. Hawver has continued the exploration of this cavern farther than it was carried by the university. In March, 1908, while attempting to open what Dr. Hawver supposed to be an ancient passageway into the lower cave, a number of human bones were found at a depth of twenty feet below the surface, under a mass of cave earth, fallen rocks and soil, over twelve feet in thickness. The remains lay at the lower end of a passageway which has evidently been closed for a long period. In this case, as in that of Mercer's Cave, remains of extinct animals undoubtedly of Quaternary age were found near the human bones, but the degree of alteration of the unquestionably Quaternary bones differs from that in the human skeletons. Some of the human bones were embedded in a cemented breccia consisting largely of angular fragments of limestone. So far as examined the bones seem to have lost most of their organic matter. A fairly preserved skull in the collection does not differ strikingly from the crania of the

[1] "Recent Cave Exploration in California," *American Anthropologist*, N. S., Vol. 8, No. 2, p. 221.

[2] Furlong, E. L., Science, N. S., Vol. 25, p. 392.

modern California Indians, although no comparative study has yet been made by a specially trained craniologist.

It is not possible in the case of the Hawver Cave relics to prove Quaternary age for the human bones. As in the other instances mentioned, the inference is, however, that the date of their entombment preceded the present day by centuries, if not by millenniums.

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SPECIAL ARTICLES

THE SCIENCE OF EXOTIC MUSIC[1]

IF architecture is the king of the fine arts, commanding the outward services of others, music is their queen, imposing the inward laws by which all rule themselves. The notions of harmony, pitch, scale, tonality and key, applied in fine art generally, have in music first become clear enough to receive names. The theory of all the arts awaits to this day the exact grasp of these ideas which the investigation of musical structure will some time give.

Hitherto the study of music has labored under an essential disadvantage compared with that of painting and sculpture. Passing events can not be scrutinized as permanent objects can. Time is lacking for their close determination; and once experienced they become memories only. Precision and revision—twin essentials of science—are possible in observing a combination of color and form, but not of tone. Hence the study of music as we know it is a study of scores. Connoisseurship, pictorial and plastic, has found its material wherever paintings and sculptures exist: musical criticism only where scores exist; that is to say only in modern Europe. In order to bring accurate method to bear on non-European music some means for reproducing it at will is demanded. If we can choose the moment when data of sense are to present themselves we can prepare for their precise registry; and the power to repeat our impressions gives the power to correct them. Such a means has been furnished within our own time and our own country. Chiefly by the aid of the phonograph inquiries into exotic music have within

[1] A. J. Ellis, "On the Musical Scales of Various Nations," *Journal of the Society of Arts*, XXXIII., 1885. J. P. N. Land, "Ueber die Tonkunst der Javanen," *Vierteljahrsschrift für Musikwissenschaft*, 1889, 1. C. Stumpf, "Lieder der Bellakula Indianern," *Vierteljahrsschrift für Musikwissenschaft*, 1886, 4; "Phonographirter Indianermelodien" (review of "Zuñi Melodies"), *Vierteljahrsschrift für Musikwissenschaft*, 1892, 1; "Tonsystem und Musik der Siamesen," *Beiträge zur Akustik und Musikwissenschaft*, 3, 1901; "Das Berliner Phonogrammarchiv," *Int. Wochenschrift für Wissenschaft, Kunst und Technik*, 22 Februar, 1908. Franz Boas, "The Central Esquimo," Bureau of Ethnology, Sixth Anual Report, Washington, 1888; "The Kwakiutl Indians," U. S. National Museum, Report for 1895. B. I. Gilman, "Zuñi Melodies," *Journal of American Archeology and Ethnology*, I., Boston, 1891; "Some Psychological Aspects of the Chinese Musical System," *Philosophical Review*, I., Nos. 1 and 2, New York, 1892; "Hopi Songs," *Journal of American Archeology and Ethnology*, V., Boston, 1908. Miss Alice C. Fletcher, "A Study of Omaha Indian Music: With a Report on the Structure of the Music by John C. Fillmore," Peabody Museum, Cambridge, U. S. A., 1893; "The Hako: A Pawnee Ceremony," Bureau of Ethnology, Twenty-second Report, Part 2, Washington, 1903. O. Abraham and E. M. von Hornbostel, "Studien über das Tonsystem und die Musik der Japaner," *Sammelbänder der Int. Musikgesellschaft*, IV., 2, 1903; "Ueber die Bedeutung des Phonographen für vergleichende Musikwissenschaft" and "Phonographierte türkische Melodien," *Zeitschrift für Ethnologie*, XXXVI., 2, 1904; "Phonographierte indische Melodien," *Sammelbänder der Int. Musikgesellschaft*, V., 3, 1904; "Phonographierte Indianermelodien aus British Columbia," Boas Memorial Volume, New York, 1906. E. M. von Hornbostel, "Phonographierte tunesische Melodien" (1905?); "Notiz über die Musik der Bewohner von Sud Neu Mecklenburg" (1905?); "Ueber den gegenwärtigen Stand der vergleichenden Musikwissenschaft," *Int. Musikgesellschaft*, Basler Kongress, 1906. "Ueber die Musik der Kubu," Städtischer Völkermuseum, Frankfurt, 1908. "Phonographierte melodien aus Madagaskar und Indonesien," Forschungsreise S. M. S. *Planet*, V., 6, Berlin, 1909. Compare also: Charles K. Wead, "Contributions to the History of Musical Scales," U. S. National Museum, Report for 1900. W. C. Sabine, "Melody and the Origin of the Musical Scale," SCIENCE, May 29, 1908.

a generation attained the standing of a branch of science.

The closer study of instrumental forms undertaken in England by the late A. J. Ellis in 1885 and carried on by J. P. N. Land in Holland laid the foundation for the new research. Five years later, in 1890, Dr. J. Walter Fewkes, of the Hemenway Southwestern Expedition, first used the phonograph in the study of aboriginal folk lore, and collected the records of American Indian singing which in the following year formed the basis of the writer's study of Zuñi melodies. The notations of singing in Miss Alice Fletcher's monograph on the "Music of the Omaha Indians," published in 1893 with a report by the late J. C. Fillmore on the structure of the music, although made by ear, were based upon years of experience in the field. In later extended studies of Indian life and art by Miss Fletcher, Dr. Boas and Dr. Dorsey the phonograph has aided. The investigation of exotic music had already occupied Professor Carl Stumpf, now of Berlin and lately rector of the university. Professor Stumpf in 1886 made an accurate study by ear ("gleichsame phonographische Nachbildungen") of the singing of Bellakula Indians from British Columbia, in 1892 gave an incisive discussion of the Zuñi melodies, and in 1901 published an extended investigation of Siamese music, based on phonographic records and the examination of instruments. Apart from the writer's volume on "Hopi Songs" (1908) all the other contributions to the phonographic study of the non-European art have come from the Psychologisches Institut of Berlin University, of which Professor Stumpf is director, and are the work of his assistants, Dr. E. M. von Hornbostel and Dr. O. Abraham. Meanwhile collections of phonographic records of exotic music have been founded in Berlin, St. Petersburg, Vienna, Paris, Washington, Chicago, Cambridge and elsewhere.

A body of material has thus been gathered and in part investigated, from which already a rich yield of new views of the art of music and its foundations in the mind of its makers either has been reaped or plainly stands ready for the harvest.

First: Anharmonic structure. As far as is known, true harmony does not exist outside of European music. Harmonic feeling has been attributed to the North American Indians; but it does not express itself in part singing and its existence is not yet satisfactorily established. It now seems altogether probable that in spite of the great development of music elsewhere no peoples but the European have ever based an art of tone upon the disturbance and readjustment of consonant combinations of notes.

Second: the isotonic scale. The initial investigations of Asiatic instruments by Ellis and Land pointed to a new formal principle deeply differentiating the music of east and west. There are neither semi-tones nor whole tones in certain scales of Siam and Java. Instead the octave is divided into equal parts, either five $6/5$ tones or seven $6/7$ tones. Professor Stumpf's later phonographic study confirmed these conclusions. A principle of tone-distance supplants the principle of consonance on which the European musical system is based. Music becomes isotonic instead of diatonic as Europeans have hitherto known it. We seem at last out of hearing of Greek tetrachords, as Stevenson, dropping anchor in the harbor of Apia, felt at last beyond the shadow of the Roman law.

Third: heterophony. A Siamese orchestra plays neither in unison nor in parts, for each of the various instruments takes its own liberties with a melody approximately followed by all. To this musical method Professor Stumpf applies the Platonic term "heterophony," and wonders whether the Siamese do not give us a glimpse of what Greek music actually was—which, as Moritz Hauptmann once remarked, "We now know only from the writings of theorists, *i. e.*, do not know at all." Such a structure results sometimes in unisons, sometimes in parallel intervals, but as often in dissonances either transient or unresolved.

Fourth: neo-tonality. As in European music so in many exotic melodies, though not in all, one note is distinguishable as the principal one. But whatever the European feeling of tonality may be, and the point is not yet clear, the regard for a principal note which

takes its place among some non-European peoples would appear a widely different thing. In some cases there is no tendency to end on the tonic note. In Kubu scales Dr. von Hornbostel finds absolute pitch an element. There remain the instances like that of Javese music in which no principal note is discoverable at all. New musical factors reaching deep into the heart of the art, seem revealed in these fundamental divergences.

Fifth: rhythmic complication. Hindu and African music is notably distinguished from our own by the greater complication of its rhythms. This often defies notation. Professor Stumpf remarks that a group of African drummers sometimes perform different rhythms simultaneously; as it were a chord of rhythms like the chords of notes to which different performers contribute in harmonic music. For its jejune structure in tone non-European music makes amends by a rhythmic richness beside which that of European music seems in its turn poverty. In Dr. von Hornbostel's words, "The vertical in the score (harmony) is the enemy of the horizontal (rhythm)." It is not impossible that this revelation of elaborate rhythm in non-European music may affect the future development of our own. The east has already profoundly influenced our painting, as it may perhaps, through some view-point hitherto unguessed, yet influence our sculpture.

Sixth: the melody type. For one element in exotic music no recognized counterpart exists in our own, and it is difficult for the European mind to obtain a clear conception of it. This is the Hindu Raga; apparently a type of melody with a delicate and abstract but very definite expressiveness. A certain Raga may, it is said, be attuned only to a certain season or time of day, and may shock the sense at any other time. This is mysterious, but the whole subject of musical expressiveness is wrapped in a mystery which the isolated students who have attacked it inductively are only beginning to enter. How can the choice of a certain step of the scale as tonic determine a "soft Lydian mode" demoralizing to the fancy? Or was modality itself in Greek music a type of melody otherwise determined and perhaps akin to the Hindu Raga? Why should medieval times have proscribed the major mode as the "*Modus Lascivus*"? In general why should a minor third upward from the tonic sound sad, and downward sound serene? Is the differing imaginative character of different modern keys a fact or a fancy? Do not all consist of the identical scale performed only at a different pitch? That these questions are, in the present state of musical science, unanswerable, evidences the indifferent equipment of Europeans for the study of the Raga. For the present it is another puzzling datum of musical expressiveness which may some day yield an explanation of wide applicability.

Seventh: scale versus song. Still another fundamental difference from European music has been suggested to the writer by the singing of the Pueblo Indians. These musicians do not seem to grasp the notes they utter as steps in any scale at all, but simply as constituents in a familiar sequence of tones, unrolling itself before the memory. This characteristic may prove the differentia of pure song from music as determined by instruments. A scale would then appear the creation of mechanisms giving fixed tones, like the lyre or the panpipes, the voice by itself knowing none. America would appear the continent of song *par excellence,* the one place where instrumental music has never attained a development capable of putting an end to the liberty of the voice. European music, wholly built on instrumental forms, again appears only one among radically distinct varieties of the art of tone.

Hitherto Europeans have believed all this alien music to be rude, primitive and nugatory—an assumption of which the present inquiries amply show the naïveté. The extraordinary exactness of ear and voice revealed in the phonographic records of some Pueblo songs is matched by the achievements of Siamese musicians in tuning their instruments, as tested by Professor Stumpf. They proved able to approximate more closely to their isotonic scale than our piano tuners commonly do to the European octave. The absolute pitch of panpipes from Melanesia proved so closely

identical with that of others from Java as to suggest an ethnic or historical affinity between their makers. This close identity between instruments of distant countries, discovered after an interval of years, bears strong testimony at once to native skill and to the accuracy of the methods employed in these studies and to the competence of the students.

To much non-European music the word primitive is wholly inapplicable. An immense development has led up to the isotonic octave. The choice of seven steps is referred by Professor Stumpf to mystic ideas of number; but he also suggests that a diatonic scale, the result of tuning by a chain of fourths, may have preceded the Siamese order. If so, the European scale, which still approximates such a tuning, is the less developed of the two. That of eastern Asia is a modification too radical to have completed itself in less than ages of progress.

Besides its frequent high refinement and artificiality, non-European music has an artistic rank of which it is hard for us to convince ourselves. Rank to its makers, be it added at once; and herein lies the widest lesson of the whole inquiry. This may be described in a phrase as the discovery of how great a part is played by the mind in apprehending a work of art; and how little of the veritable creation can often be grasped by an alien. Professor Stumpf cites a striking example. Since c-e-g on our instruments is a major chord and e-g-b a minor, the two sound to us major and minor, respectively, on a Siamese xylophone, where they are, nevertheless, identical combinations. In like manner a comparison of the tone-material in phonographic records with the same melodies heard currently makes it apparent that Europeans apprehend all music in the diatonic terms familiar to their ears. From the first employment of the instrument doubt began to be thrown on the earlier notations by ear which exhibited exotic music generally as a poor relation of the European family. Psychologically, the value of these results as a notable instance of the dependence of sense on fancy is very great. As a discipline in liberal culture compelling us to seek for the standpoint of other minds, they will be invaluable to all privileged to follow them. It is our own ears that are oftenest at fault when we hear in exotic music only a strident monotony or a dismal uproar to be avoided and forgotten. To most non-Europeans their music is as passionate and sacred as ours to us and among many it is an equally elaborate and all-pervading art.

The influence of European music becomes every day more audible in the singing and playing of non-European peoples. The time seems not far off when the task of dissecting out aboriginal elements will become impossible. As the ornament in Queen Ti's tomb fell to dust at the entry of the explorer, so exotic music is already dying on the ears of its discoverers. The life of the science has inexorable limits, and if it is to yield what it might, the number of those who pursue it and the money at their command must at once be greatly increased. The results of a few years' work by a few students sufficiently show the absorbing interest and the wide-reaching value of the study; and should bring out both material and personal aid in plenty from lovers of music, of ethnology and of the humanities. What men of means or of science will offer their fortunes or themselves for this imperative labor?

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THE RELATIONSHIPS OF THE ESKIMOS OF EAST GREENLAND

Dr. W. Thalbitzer describes in the "Meddelelser om Grønland," Vol. XXVIII., the Amdrup collection from east Greenland, which comprises objects found between the sixty-eighth and seventy-fifth degrees of north latitude. The publication is of great interest, because it brings out conclusively the close relationship between the culture of the northeast coast of Greenland and that of Ellesmere Land, northern Baffin Land and the northwestern part of Hudson Bay. The similarities are so far-reaching that I do not hesitate to express the opinion that the line of migration and cultural connection between northeast Greenland and the more southwest-

erly regions must have followed the shores of Ellesmere Land, the northern coast of Greenland, and then southward along the east coast. One of most suggestive types found in Dr. Thalbitzer's publication is the needle-case figured on page 421. I have called attention to the distribution of this type of needle-case in my paper on the "Eskimo of Baffin Land and Hudson Bay,"[1] and in a discussion of the decorative designs of Alaskan needle-cases.[2] The specimens described in these two publications are from Frozen Strait in Hudson Bay, Ponds Bay and Smith Sound. Later on I published another needle-case of the same type from Rawlings Bay in Ellesmere Land. Among these specimens only those from Ponds Bay and Smith Sound are found in actual use, while the others were collected from ancient house-sites. Two similar specimens are figured by Dr. Thalbitzer (p. 527). These were found in the region of northwestern Greenland, that is, near the island of Disco. It is important to note that the ornamentation on the large specimen here figured is identical with the alternating spur decoration which was discussed by Stolpe in his studies of American ornament, and by myself in the discussion of Alaskan needle-cases before referred to. The same ornament occurs in the ornamentation of a comb shown on page 472 of Dr. Thalbitzer's publication.

Among the other specimens, sealing-stools (pp. 430, 431) seem to be particularly important. They are very similar in form to a specimen found by Peary in Grinnell Land.[3] The ice-scraper of bone figured on page 438 must be compared with the set of implements shown on page 409, "Eskimo of Baffin Land and Hudson Bay." Even the perforation for suspending the scraper agrees with those of specimens from Southampton Island. There seems to me little doubt that the hammer-like implement illustrated on page 442 of Dr. Thalbitzer's publication is a blubber-pounder similar to those made of musk-ox horn illustrated on page 402 of my paper on the "Eskimo of Baffin Land." The bone heads of adzes[4] agree fairly well with those shown on page 381.[5] The decoration on the handles of the bodkins[6] may perhaps be compared to the handles of the wick-trimmers from Melville Peninsula.[7]

All these types which show close correspondence in form are so much specialized that they must be considered as evidence of old contact or of sameness of origin. So far as I am aware, none of these types have been found in the region between Disco and Cape Farewell, nor do they occur in Angmagsalik. If this is true, the conclusion seems unavoidable that the Eskimos reached the northeast coast of Greenland by way of the north coast.

C. Ryder has called attention to the similarity of some of the east Greenland types to those from Alaska, and Thalbitzer again calls attention to the similarity of the harpoon-shafts to those of Point Barrow (p. 444). I have called attention to several other similarities of this kind, particularly the alternating spur decoration, to which Thalbitzer also refers (p. 472), and the forms of several specimens.[8] Similarities between the Ponds Bay region and the western regions have also been pointed out by Dr. Wissler in his description of a collection made by Capt. Mutch at my instance in that region.[9] The distribution of types suggests very strongly that a line of migration or of cultural contact may have extended from the Mackenzie region northeastward over the Arctic Archipelago to north Greenland, passing over the most northerly part of Baffin Land, and that the culture of southwestern Greenland, and that of southeastern Baffin Land and of Labrador, must be considered as specialized types.

Franz Boas

[1] *Bulletin American Museum of Natural History*, Vol. XV., part 2, p. 433.

[2] *Proceedings of the U. S. National Museum*, Vol. XXXIV., p. 326.

[3] "Eskimo of Baffin Land and Hudson Bay," p. 463.

[4] Thalbitzer, p. 449.

[5] Boas; compare also *ibid.*, p. 416.

[6] Thalbitzer, p. 399.

[7] Boas, p. 403.

[8] Boas, pp. 461–464.

[9] Anthropological Papers of the American Museum of Natural History, Vol. II., Part III., pp. 316–318.

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

A CAREER IN MEDICINE AND PRESENT-DAY PREPARATION FOR IT[1]

Mr. President, Members of the Governing Boards and of the Faculty of Leland Stanford Junior University, Students in the University and Guests: It is my privilege to come at the invitation of this university to share in the inauguration of a new department in the university. To-day you are commencing a work which means much for the progress of medicine in this fair land of ours, and to be permitted to share in these exercises is a privilege and an honor which I esteem highly.

I come, too, bearing to you the greetings and good wishes of the faculty of medicine of Harvard University, who welcome you into the fellowship of university medical schools. This band of university medical schools is as yet but a small one. However, in the last decade and a half a slowly increasing number of medical schools have developed as integral parts of universities, constituting genuine university medical schools. Unfortunately this number is even smaller than is at first apparent, for in some instances the union between medical department and university is merely nominal. Small, however, as is this group, it has already exerted a powerful influence on medical education and has been one of the forces at work changing medical instruction and medical schools to keep pace with recent wonderful developments in medical science, and it will play a yet larger part in the medical uplift of the future. To strengthen this group with a

[1] Address at the dedication of the department of medicine in Leland Stanford Junior University, September 8, 1909.

medical school supported by the great resources of this university means much, therefore, as I have already stated, for the progress of medicine in this country, and the medical profession is to be congratulated on your determination to begin a medical department.

It may not be inappropriate at this time, before an academic audience, to discuss the possibilities of a career in medicine and present-day preparation for it, incidentally considering some of the many problems of medical education and indicating the magnitude of the task that lies before this institution in developing a medical department that shall be a credit to the foundation so bountifully provided by Leland Stanford for a great university in this glorious state of the Pacific slope.

If I may be permitted to subdivide this audience, I will address myself especially now to the students present and indicate, as best I can, what a career in medicine has to offer those who undertake the study of medicine. I would have you consider medicine broadly as one of the biologic sciences to be entered into after a collegiate training with some knowledge of others of the group of scientific studies, more especially of chemistry, physics and zoology. After the preliminary training the prospective medical student must devote four years to medical studies, and at the end of these years he should enter a hospital for one or two years of practical work; in all, six years of medical training. At the expiration of these years he may do one of several things: he may begin the practise of medicine; he may become a surgeon, a medical consultant or a specialist; he may choose teaching and investigation, or he may devote his energies to public health work. Here is a wide variety of possibilities for his selection. Which is he to take? Personal desire and adaptability are important factors in the choice. Each offers its own attractions and rewards, measured often by different standards.

To the many in our medical schools the practise of medicine will open its doors and to most of you this work—that of the family physician—is best known. He who enters into the practise of medicine may look forward to a moderate income measured by the standards of modern business and a life that will bring him into a peculiarly intimate, serviceable relation with his fellow men. Probably in no other calling is there such an intermingling of work for wage and work that brings its blessings to others, and in this lies the peculiar charm of the practise of medicine. The physician's advice not only is sought in matters of health and disease, but gradually he grows to be family councillor too, the recipient of family secrets and a sharer in family joys. In many communities the physician is an important figure in all that pertains to the activities of the place, often filling positions of responsibility, a man honored, loved and respected by his fellows. Freely he gives of his time, his mind and his love; but equally great is the reward which he reaps in the gratitude of his patients and in the satisfaction of knowing that within his limitations he has richly given of the talents vouchsafed him. Many are his opportunities for doing good to his fellow men, nobly does he respond to these calls. The charity of the rank and file of the medical profession throughout this broad land of ours is one of the glories of medicine. So to engage in the practise of medicine offers you many opportunities to do good and at the same time this work will furnish you a living income, gained soonest in the smaller places, while in the large cities there are opportunities for obtaining incomes of even large size, but it must be realized that in the large city, though there are great prizes to be won by a few, there are many who will fail in the

competition for them, and the smaller place offers a more certain reward to the medical man of good training, good habits, good health and perseverance.

A smaller percentage of medical graduates may continue their preparation beyond that of the practitioner, with the intention of becoming surgeons, medical consultants or specialists. More and more at the present time is surgical work done by men specially trained and who confine their work to surgery as opposed to the older plan, very generally followed, of each physician doing some operative work. Even with a very great increase in the number of diseased conditions amenable to surgical treatment, one skilled surgeon can do all of the work needed by a population of considerable size and not a very great number of surgeons are needed in a community. Consequently only a comparatively few are likely to attain to success in this branch. For the few who do, the reward is great and the successful surgeon obtains an income large even when compared with the incomes of present-day industrial life, but this success comes only after a period which has involved a number of years' preparation beyond that received by him who enters general practise. A considerable special knowledge of anatomy and pathology is needed by the surgeon and this entails many hours of painstaking work. Then comes the period of assisting some trained surgeon, gradually attaining the manual dexterity and the knowledge that are required for the surgeon. The surgeon's apprenticeship should last six to eight years, years in which his earning capacity has been relatively small and his labors arduous. Remembering this, the surgeon surely deserves a good income when his period of matured activity comes and a small group of men can anticipate this success in surgery.

For the medical consultant a very similar period of preparation is required. This possibility to the young graduate is essentially a recent development in medicine in this country. In the past, the medical consultant has been almost invariably a man of mature years, trained by an extensive general practise from which he has gradually withdrawn as his consultation work has grown. Now there is a field for a differently trained consultant, though there is undoubtedly still a place in consultation for the matured judgment of the general practitioner, where his practical experience is of extreme value. Still the young graduate to-day can deliberately train himself for consultation work. A few years should be spent by him in the laboratory gaining first-hand knowledge of some one of the fundamental sciences of medicine, anatomy, physiology, pathology, bacteriology, chemistry or pharmacology. Then a large part of his time should be devoted to work in the hospital, where he may combine observation of many patients with laboratory investigation, supplementing all, of course, with study of medical literature. Five or six years of such work will give him a deeper knowledge of the facts and methods of medicine than many more years spent in general practise, and this knowledge should be useful to the general practitioner, too busily engaged with routine for maintained study of a subject which like medicine is constantly progressing and developing. Gradually there has come a call for the consultant so trained and I believe in the future an increasing number of consultants will be thus trained and this field of work will be offered as a possible career for the graduate in medicine, yielding him a better income than general practise, though rarely as great as that gained by the successful surgeon.

There are various fields of special medical work open to graduates, such as diseases of the eye, the ear, the nose, etc. In

all of these in the larger places there are men who limit their work to some one of these special branches and for which work they have prepared themselves by several years of special study. In almost all of these special branches of medicine, practise differs from the other fields of medical work already described in that a very large per cent. of the patients come to the office of the doctor and practically all of the work can be done within certain fixed hours, leaving greater freedom to the physician, and this, to many, forms an attraction in these specialties beyond the considerable income that may be derived from their practise.

To the graduate in medicine to whom active practise does not make an appeal, the quiet life of the laboratory and the lecture room is open. Teaching and investigation in medicine, as in other branches of university work, demand a certain number of men. In recent years the demand in this field has been rather in excess of the supply and for a few years this demand is likely to increase gradually, for more and more medical schools are placing the instruction—at least the instruction of the first half of the medical curriculum—in the hands of men who give all of their time to instruction. In addition, various institutions of medical research, independent of medical instruction, have been founded and these require men of medical training to conduct their investigations. Hospitals now employ various laboratory-trained men and furnish occupation for many of this class. So far the demand from hospitals has been largely for men of pathological training, but now the chemist and the physiologist begin to be sought. Clinical teaching and investigation as a career is just beginning to develop in this country, but surely in the near future there will be a considerable demand for men adequately trained for this work. Medical investigation offers a fertile field for the properly qualified man and in it honor and fame will be won in the future as in the past. Teaching in medicine has a certain advantage over academic teaching as a career in that often with the teaching there is combined the opportunity for some remunerative use of the same training as renders the individual successful as a teacher; I refer to demands for his aid in various diagnoses, or the possibility of combining teaching with some salaried position in a hospital or mingling with the teaching a certain varying amount of special practise. In these ways the teacher in medicine is not as absolutely dependent on his salary as a teacher of most other subjects, and in case a teaching berth grows unacceptable, he may fall back on the practise of medicine for a livelihood.

I have not particularly enlarged upon medical investigation as a career, since it is included now so generally in the career of teaching and because pure investigation is not so much planned as a career as the true investigators—very few in number—are spontaneously drawn into it.

Public health work is almost in the beginning of its development in this country, but in a few years it is to be anticipated that there will be a very considerable demand for men trained in hygiene and preventive medicine to serve as health officers and sanitary advisers at good salaries. This is a demand for which our medical schools are just beginning to provide by the establishment of departments, but the next few years will show great advances along these lines and many men will be attracted by this field of work.

I have attempted to point out to you that the prospective medical student is not entering on a career of very limited possibilities, but that after graduation he has considerable choice as to his future work and may choose among several forms of

medical activity that for which he is best adapted.

To the members of the faculty it is evident that to equip students for these various phases of the medical career, a medical school must possess extensive equipment and large resources to which it receives students with adequate preparation to profit by the instruction offered. During the past five years much progress has been made in elevating the standard of medical education by increasing the entrance requirements to our medical schools. There has been much discussion as to the best preparation for the study of medicine. Training in chemistry, physics and zoology with a reading knowledge of French or German are very generally deemed the essentials of a satisfactory preliminary preparation for medicine, because medicine itself is very largely a biologic science, using the methods of these other sciences, and because in the study of anatomy, physiology and medical chemistry much time is otherwise consumed in teaching what the student might readily have learned in college, while the modern languages are needed that the student may utilize more extensively the literature of medicine. Just how much general college training beyond these subjects should be required has been largely debated. No one would deny that the better education the student has before he begins medicine, the more he is apt to profit by his medical studies, yet this may be readily carried to an absurd point since preliminary work consumes time and too much of it would make the period of medical study come too late in life. A college course of three, at most, four years, including work in physics, chemistry, zoology and modern languages and leading to a degree of A.B. or B.S., is at present regarded widely as an ideal preparation for the study of medicine, but this is open to the criticism that it gives us in the medical schools students of too old an average age. Assuming that such a college A.B. or B.S. course is an ideal preparation for medicine, it has already been adopted in several medical schools making the period between entrance to college and the commencement of the practise of medicine a period of from eight to ten years, divided as follows: college three to four years, medical school four years, hospital one to two years.

At present, after such preparation, most men begin medical practise too late in life. To start them earlier in their life work is one of the great problems before us. This can be done best, I believe, by, in some way, lowering the age of entrance to college —perhaps by changing instruction in the preparatory schools. Another method of lowering this age has been sought in the so-called combined course by which the A.B. degree is awarded at the expiration of four years' work, two years' college work, including physics, chemistry and zoology, and two years' medical work and the M.D. degree at the expiration of two more years, a total of six years instead of seven or eight years for the two degrees. But do not let ourselves be deceived by this. Reduced to plain facts this means two years of college work, including physics, chemistry and zoology, as an entrance requirement to the medical school, and such institutions as have the combined course are to be classified in the group of medical schools requiring only two years of college work for entrance unless we attribute some intrinsic educational value to the right acquired by the students of adding A.B. after their names—a thing which I take it no one would claim. Rather does it seem to me that these schools have succeeded in rendering the A.B. degree of less value and significance than formerly and have sacrificed one or two years of college work while seeking to conceal this fact by the award of the two degrees, A.B. and M.D. In the

combined course two years of work are counted for two degrees, another fact which has brought criticism on the plan.

It must be remembered, in discussing entrance requirements, that it is not yet proved whether one or two years of college work beyond the two years demanded by many medical schools as an entrance requirement is of more advantage than a one or two years' earlier start in medical work. It is very generally conceded that a knowledge of physics, chemistry and zoology and the ability to read French and German medical literature, are very helpful to the medical student of to-day who pursues a quite definite curriculum of study, and this knowledge can scarcely be obtained in less than two years of college work. Beyond this we are still experimenting, and gradually by comparing graduates under varying entrance requirements we may satisfactorily solve the problem. It is very important that this be done, and for this reason I have discussed the combined course and pointed out that it should be classified where it belongs,—*i. e.*, as two years of college work for entrance to the medical school.

The problem is further rendered complex by students transferring from one school to another. A university, in fact, may discriminate against its own students if it requires a degree for entrance, does not give a combined course and accepts students with credit for advanced standing who have had part of a combined course. Under these circumstances a graduate of its own collegiate department must spend at least one, possibly two, more years between college entrance and graduation in medicine than the student transferred from the institution giving a combined course. This actually happens in certain institutions. So in the solution of our problem students transferred from one school to another must be carefully classified to prevent incorrect deductions from our statistics.

Making these allowances, we have now very fair conditions for comparing students with various preparations, since schools with good medical equipment are making these different requirements for entrance. The evident advantages so far gained by demanding for entrance to the medical school, a college degree with certain specified studies are: a more mature, uniformly trained student easier to teach; a decreased number of students receiving more personal attention, and an increased number of hours available for medical studies gained by the relegation to college of preliminary courses in physics, chemistry, zoology and botany, formerly included in some form in the medical curriculum. Opposed to these are certain disadvantages: the relatively old age at which the medical man actually begins his life work; the barring of medicine to men unable to secure the preliminary education among whom will undoubtedly be men of great potential ability; the possible lowering of the standard of country practitioners, as the college-bred man tends to have an aversion to country life and will leave country practise to graduates of the poorer medical schools which usually keep behind the latter in their demands for preliminary education. To-day the advantages appear to outweigh the disadvantages, though it does not seem advisable were it possible to increase at once entrance requirements in all schools to a college degree. To have done so in certain schools has greatly benefited medical education, but the future may show that the pendulum has swung too far or that it has not swung far enough. We must regard the matter as still in the experimental stage and every institution must seek to contribute towards its solution.

Having determined on a standard for

admission to the medical department here at Stanford, what preparation should the faculty seek to give its students for a career in medicine? It is evident that if, as I have pointed out, the career of medicine offers several possibilities for life-work, the medical school must furnish a certain elasticity of preparation. However, you must recognize first of all that by far the larger number of your students will become general practitioners and the world at large will judge the success of your medical school by the type of general practitioner you send out. To the casual observer a medical school is merely a place for training men for the practise of medicine—it is to them a technical school, not a university department. So you must seek to train your men for this part of the career of medicine as well as it is possible. On them will rest a great responsibility—the responsibility of giving to their fellows the best that modern medicine has to offer in preventing disease, in mitigating its pains and in curing its attacks. With a broad knowledge of medicine as a biologic science, with an intimate knowledge of the normal and abnormal mechanism of mind and body, with a rational grasp of all forms of therapeusis and a thorough training in the diagnostic methods of medicine, you must prepare your students for this responsibility. There will, of course, be laboratories and clinics with adequate equipment, representing an investment of many thousands of dollars. Men to man these you will secure, choosing the best in the land, for after all, men more than buildings are the particular pride of universities.

The organization of the departments giving instruction in the first two years of the medical curriculum is easier to-day than of those dealing with the later years, the clinical instruction. In our medical schools there is more uniformity of instruction in anatomy, physiology, chemistry, pathology and bacteriology than in the other branches of the medical course, and I believe good instruction is more generally given in these. One reason for this is that the necessary money is the only limitation to the possession of satisfactory laboratories and to obtaining competent men for these subjects. Sufficient material for instruction is usually quite easily obtained. On the other hand, to the satisfactory development of clinical instruction conditions in American medicine have furnished many obstacles—obstacles which I trust this university is to take an active part in removing. For satisfactory efficient clinical teaching hospitals are absolutely essential with many patients with which students can come into close contact. The separate development in America of hospitals and medical schools has retarded clinical teaching. In this country hospitals are usually municipal or privately-endowed institutions under their own governing boards. With rare exceptions do medical schools exercise any influence in determining staff appointments in these hospitals. In them seniority promotion is often the rule and this in itself withdraws a very strong stimulus for the best work and acts to retard the development of members of the hospital staff. Under these conditions the medical school has but little choice in its selection of professors and instructors in clinical subjects. The man controls the clinical material which the medical school must have and so he becomes professor whatever may be his qualifications for teaching. Very generally in our hospitals members of the staff are on duty but three or four months of the year. This necessitates multiplicity of teachers and prevents continuity of instruction and investigation. These are factors on the side of American hospital organization which have acted to retard clinical teaching and clinical investigation and which should be changed in

the future. A medical school must control appointments in the hospitals where its clinical teaching is done and the terms of service must be continuous throughout the year if the highest development is to be attained. Clinical professors, like other university professors, must be chosen because they are the best teachers and investigators available and this can never be the case so long as only local men are possible of selection.

Medical schools themselves have been responsible in part for the present state of clinical teaching on account of the very meager salaries, or worse still, no salaries, paid its clinical teachers. This has resulted frequently in teaching receiving just as much attention as under these conditions it deserved, *i. e.*, secondary consideration. Medical schools have expected the clinical teacher to be remunerated by the advertising the position gave him and when the advertising was profitable they have complained because private practise has interfered with school work. What else, pray, could be expected? Let us suppose that a university had attempted to develop its chemical department, for example, by limiting its choice of instructors to its locality, paid them slight or no salaries, asked them to make a livelihood doing private chemical work, such as assays, etc., and had them work in buildings and with apparatus owned and controlled by another corporation. How absurd the proposition! How could a university chemical department develop under these conditions? Yet these are conditions not essentially different from those under which many, many medical schools have attempted to develop clinical departments.

I would impress on the governing boards that a medical department is very expensive. Numerous laboratories are needed, and much apparatus. Professors and instructors in the laboratories must be paid university salaries and often the maximal salaries, since there is a growing demand for the better instructors, and an institution can not afford to lose too many of its trained men. Clinical professors must be paid salaries, too, in proportion to the time they give to teaching work. Of clinical teachers there should be two classes, those who devote a large part of their time to medical school work and those who devote a small part. In the first group should come at least the heads of the more important departments, such as medicine and surgery. Some advocate having professors of medicine and surgery who engage in no private practise but confine their work to the medical school and the hospital. It is an advantage, however, to my mind, for them to do a limited amount of private work because much of the best material for study comes through these channels and, on the other hand, the public has a right to some of the services of these more highly trained men. These men will probably have to be paid more than university salaries for both hospital and medical school work, since they would be men who in private work would earn far larger incomes. In addition to these men devoting the major part of their time to academic work, the services of the men in private practise are needed. They are in a position to teach to students particularly well the art of medicine, if I may use the word without being misunderstood. From their particular experience they have something of value to impart to students and they should be made use of and paid in ratio to the time devoted to teaching. Then the medical school of to-day requires a very large teaching force, since so much of the teaching can be done satisfactorily only in small groups of students. This again increases the cost of medical instruction.

In medical schools the older fixed curriculum is giving place to a modified elect-

ive system in order that medical instruction may have that elasticity demanded by the different possible lines of work to be followed by the graduate. Election within the medical curriculum is at present somewhat limited by the requirements of the state licensing boards and as almost all graduates will practise medicine in some form, each medical school must offer a curriculum meeting the requirements of these boards. However, such can be met and still the student be allowed considerable freedom of election. At Harvard there is now complete freedom of election in one year of the four years of medical study and this has proved a satisfactory arrangement. This question of freedom of election in medical studies must be carefully considered in the future. It must be recognized that our present more fixed curriculum has been somewhat more an accidental development than a studied, planned growth. New subjects of a developing medical science have in the past been crowded into the curriculum. Now that is full and new subjects can be added only as the result of readjustment of the curriculum or be left to an elective period. This fact will necessitate in the future change in our medical instruction and will be a probable cause of extension of election in medical studies. If a very free elective system develops, entrance requirements again will need readjustment and these are problems for much thought by medical pedagogians. The proper position of the so-called specialties in the medical curriculum will be another problem for future consideration. A glance at the course of study in different medical schools will show much variation in the number of hours required in this or that specialty, indicating the action of local influences more than thought as to the real needs of the students. An elective system may aid in adjusting the specialties but still a necessary minimal must be determined for the student destined for general practise. Up to the present time the gradual growth and development of special fields of medical work has exerted a disintegrative influence on medical instruction resulting in a higher development of the resulting parts, but now there is need for integration and balanced adjustment of the parts to form a more perfected whole.

In a medical school equipped for proper training of practitioners there will, of course, be laboratories and men capable of conducting advanced work in various branches of medicine, to prepare students as surgeons, consultants, specialists, teachers, etc. This part of the medical work constitutes university work in the usually accepted idea in contradistinction to college and technical-school work. Advanced students and instructors will conduct investigations and publish, for the use of the world, their results. Without this no medical school can be regarded as a university medical school. What attitude should the university at large assume toward university medical work? There has been a marked tendency on the part of academic circles to disparage the work of medical departments and a lack of disposition on the part of university professors to accept work in medical subjects as university work. Happily this attitude is disappearing, though in rare instances is the medical work accorded its true place in the university organization. There is no essential difference between the methods followed by the pathologist in his investigations and those followed by the zoologist in certain of his fields of work; the medical chemist uses the technical procedures of the organic chemist; the bacteriologist is an investigator in a special field of botany. That, in the medical departments, man and his diseases is the ultimate subject of study is no reason for regarding these studies as less

cultural than other university subjects. Is there any real reason why an advanced student in zoology should be awarded a higher degree, such as that of doctor of philosophy, for special sustained work in that subject, while this degree is withheld from the advanced student in pathology or anatomy or any other medical subject? You all know the opposition offered by the departments of literature, language, philosophy, etc., in the past to the recognition of the sciences as university subjects and parts of the curricula of candidates for the bachelor of arts degree. Gradually, however, this opposition gave way and the sciences were received by the academic councils on the same footing as the older humanities. Some such process is now going on in medical subjects. I believe the day will soon come when higher degrees will be awarded for medical studies, just as for other university subjects. Perhaps some of the faculty present may resist this move. I trust not, but if they do, I feel sure that eventually they will be on the losing side. Harvard, I am glad to say, has already recognized this claim of medicine and there is, in the organization of the faculty of arts and sciences of Harvard University, a division of medical sciences similar in organization to the division of ancient languages, or other divisions of that faculty, granting higher degrees—master of arts, master of science, doctor of science and doctor of philosophy—as in other divisions of the university faculty of arts and sciences. This division of medical sciences is composed at present of members of the departments of chemistry, physics and zoology, of the faculty of arts and sciences and of members of the departments of anatomy, comparative anatomy, physiology, comparative physiology, pathology, comparative pathology, bacteriology and biological chemistry, of the faculty of medicine and there are candidates for higher degrees working in several departments of the Harvard Medical School.

The next logical development in medicine as a university subject will be the acceptance of some of the clinical branches as proper training for higher degrees. I realize that this idea will be repugnant to many in academic circles who regard medicine and surgery as purely technical professions. A comparatively few years back and such was the case. Examination of a modern department of medicine as an example, however, serves to show that there have been great changes in the past twenty years and that now there is much similarity in the methods and ideals of a department of medicine to the methods and ideals of the various university departments. The department of medicine of a present-day university medical school has a laboratory equipped with apparatus for chemical, pathological and physiological investigation and men capable of utilizing this equipment in investigation. By the experimental method diseases are produced and abnormal functions studied. The hospital, with its patients, is another great laboratory into which natural disease comes for investigation and the attitude of the department of medicine toward the hospital is not essentially different from that toward the laboratory. The student and investigator in both seek to add to the knowledge of disease facts that may eventually be applied to the alleviation and prevention of the sufferings of humanity. In the hospital are individuals seeking cure from disease and the physician brings to their aid all that medical science can offer. In the diagnosis of their disease the methods and resources of the laboratory are utilized. The treatment applied often has been evolved as the result of animal experimentation. The result of the treatment on the particular individual is part of a great experiment built up of innu-

merable observations of just such individual cases. To each individual the physician applies the method which, based on previous experience, would seem to offer him the greatest aid. In receiving the best that medicine has to offer, the patient is contributing a part to further advancement of medical science. It is universally conceded that a university hospital with such a relation to laboratory and medical instruction affords its patients the most accurate diagnosis and the best treatment possible.

Now, if in such a department of medicine investigations are conducted by the methods of the biologic sciences with the view of adding something to the sum total of human knowledge, is there any essential difference between its methods and ideals and those of any university department?

Many studies of the heart beat in animals have been awarded a Ph.D. degree in university departments of physiology. If in a department of medicine the heart beat of man is studied, should less credit be given for equally good work? Surely, the turtle's heart beat is of no greater import than that of man. But you say that in the turtle you can control the conditions of the experiment—not in man. True, but in man, natural disease often performs the experiment for you. Take the condition of heart-block in which disease has severed the continuity of conduction impulses between the auricles and ventricles of the human heart, and produced disturbances in the cardiac system which may be investigated during life by methods of the physiological laboratory applied to man. Investigations of these conditions controlled by animal experiments in the laboratory have already thrown much light on the physiology of the heart and seem adequate for higher degrees, if higher degrees are already awarded for quite similar studies in university departments. This is merely an example of many others that might be cited. Thought on these will, I am sure, convince you that to accept certain forms of work in modern clinical departments for higher degrees is not irrational. Work of this type should afford the best preparatory training for teachers in clinical subjects, as is universally acknowledged to be the case for other university teachers. A medical school thus organized as part of a university will form both the best type of professional technical school and a real university medical school. Nor will the advantage of such an organization be solely on the side of the medical school. The separation, in this country, of the medical school and the university has taken from the university the activities of men who, in other countries have added much to the glory of the universities. The medical school will find inspiration in the ideals and spirit of university work, and the essential unity of medical science and other sciences will be realized in this country when universities and medical schools are closely united.

The development in the west of great universities has brought to the east the stimulation of competition and has resulted in increased development of the eastern universities. The development of western medical schools will, in the same way, stimulate progress in eastern medical schools. We, of the east, have welcomed the organization here in the west of university medical schools, realizing that you will take students that otherwise we might get, but knowing that, from your work, we shall learn, that as you grow we shall grow and that American medicine in this way will attain to that development which the resources of this country amply justify. So we all wish you God-speed in the undertaking which you are inaugurating to-day and gladly welcome you into the brotherhood of medical schools. We shall watch

your development with the greatest interest, expecting to learn much from the way you meet the educational problems of a developing medical science.

To the authorities of Stanford University I can only say, cherish well this new offspring of your university, nourish it carefully, expend on it richly of your resources, that an institution may grow here, a pride to the university, to the state and to the country. In its proper development you will richly reap from your investment, even though the investment be very great. May the medical department of Leland Stanford Junior University have a long and useful career, may its faculty and students contribute richly to the widening of the horizon of medicine, and may its future graduates carry comfort and healing to thousands of suffering humanity.

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SUGGESTIONS FOR THE CONSTRUCTION OF CHEMICAL LABORATORIES[1]

General Construction.—For a chemical laboratory there is probably nothing better than the so-called slow burning or mill construction. While lath and plaster may be more handsome from an artistic point of view, yet it suffers from the serious disadvantage that the ceiling becomes disintegrated from the acid fumes, with the inevitable result that it drops into the quantitative determinations, to their ruin, or hangs in festoons or fragments that are anything but artistic.

Walls.—The walls should, if possible, be faced with white glazed brick; if this be prohibitive on account of cost, at least where they are exposed to view. In place of this, possibly pressed yellow brick, white "silica" brick, or ordinary red brick painted white may be employed. The paint employed should contain no "white lead," but may be sublimed lead ($PbSO_4$), barytes or zinc white, or preferably a mixture of these in about equal proportions or lithopone. Some of the so-called cold water paints have been used with fairly good success. They may turn black in damp weather, but usually return to their white color when dry.

Floors.—If care be taken to keep the joints tight between the walls and floors there is probably nothing better for a laboratory floor than asphalt. The writer knows of some laid twenty-five years ago that have required no outlay for repairs and are apparently good for another quarter century. Laboratory desks and heavy apparatus should be supported on a broad framework to prevent them from sinking too deeply into it. The asphalt, as wood floors, should be laid upon a heavy grooved and tongued wooden floor with paper between. These floors can be supported upon double wooden beams or upon iron beams kept well painted with a metal varnish coating. Rift hard pine, birch or maple, when carefully selected and laid, makes a good floor, particularly if kept well oiled. This has the disadvantage of making it slippery. It is of course not as tight as an asphalt floor.

Ceilings.—Too much attention can not be paid to their construction, as the writer knows of three large new laboratory buildings in which a more or less constant precipitation of sawdust, paint and plaster is taking place upon the floor below, because of an oversight in this particular. This, in one case, is due to the application of a cold-water paint, which is scaling off from the ceiling when the floor above is walked upon. In the other two cases sufficient care was not taken to sweep clean the first layer of floor boards before laying the second. All

[1] This paper was practically in its present form in November, 1907, nearly a year before the articles lately published in Science.

this can be obviated by putting in a ceiling of matched boards *after all floors have been laid.* It should be finished with shellac or coach varnish. Something of a pitchy or resinous nature should be used (and yet contain no common rosin, as that is far from durable), rather than a paint which can peel or flake off. This should be borne in mind in all overhead construction. As has been said, plaster of any kind is inadmissible in a ceiling on account of its disintegration by acid fumes. Cement is no better, as in one laboratory of which the writer knows, a cement ceiling began to flake off within about six weeks after occupation.

Fire Walls and Protection.—The building should be subdivided into areas of suitable size by fire walls extending from top to bottom; all apertures in these walls should be guarded by automatic fire doors. The library, if there be a departmental one, should be housed in a fireproof room and also be protected from being flooded by leaks on the floor above. The more dangerous laboratories—the organic, the oil testing and those below or adjacent to the library should be rendered safer by the installation of sprinklers. Somewhere in the building there should be a fireproof room for the distillation of inflammable substances. In addition to fireproof stairways a sufficient quantity of outside iron fire escapes should be provided and the exits thereto carefully indicated and kept unfastened. Inch rubber fire hose with nozzle should be provided in each laboratory. Rubber is better than linen or any other collapsible type of hose, in that it does not kink and thus can be taken through doorways when there are self-closing doors without checking the stream of water. A number of small hose are better than large hose in the hallway, in that they are more accessible, and if used, do not deliver such a torrent of water as to occasion a greater loss from water than from the fire itself. Pails of sand with scoops are very efficient and should be found in every laboratory. No money, however, should be wasted on the purchase of "dry powder fire extinguishers," of which Dr. Freeman says "we recommend that they be thrown into the rubbish heap."[2] If these are wanted they can be easily made by filling tin tubes with two or three pounds of "anchor dust" or waste bicarbonate of soda. In the organic and oil testing laboratories or any other where the fire risk is unusual, in addition to these safeguards above mentioned and automatic sprinklers, some type of portable chemical fire extinguisher should be included. This, as is well known, employs carbonic acid generated by the action of sulphuric acid upon baking soda to throw a stream of carbonated water about, which is especially effective in tar and chemical fires.

A large douche bath with quick opening valve has been found very convenient in extinguishing fire on a student's clothing. This is merely a rose, or better a flat hollow disk a foot in diameter with concentric slits in it, through which the water issues in a shower; it is set seven feet from the floor.

Heating and Ventilation.—The so-called "plenum system" for the general heating and ventilating of a laboratory building may be said to work fairly well, but it must be supplemented by steam radiators and by independent fans, one or more for each laboratory, drawing upon the hoods. These can be placed in the laboratory or, better, on the roof. The hoods in addition to having the usual outlets at the top should be provided with an outlet at the bottom, as most of the gases and vapors of which the

[2] "On the Safeguarding of Life in Theaters," p. 87.

chemist wishes to be rid are heavier than air. Besides the fan draft in the hood the flue should be so arranged that a good sized Bunsen burner can be kept burning in it for use when the fans are not running.

Hoods.—These can in general be disposed of about the laboratory walls and be constructed of wood, pine, white wood, cypress or "asbestos wood" or "asbestolith" with wooden or asbestolith sashes. Where the material is exposed to steam, hot air, or unusually corrosive agents, they perhaps can be made of glass, wired glass, admitting of large panes set in lead-covered sashes.

Iron settings for the glass, unless kept well painted, are not to be recommended. Possibly these sashes may be omitted, and the hoods built after the manner of show cases of plate-glass show windows, by drilling and holding the glass plates in position by angle irons kept well painted with a pitchy "paint." The backs and tops of the hoods can be lined with the same material, where wood is inadmissible, and it is desired to secure freedom from scaling from the brick walls. The use of hoods extending over each desk, as in Edinburgh, is of doubtful expediency and renders the laboratory dark and fills the ceiling up with their exit pipes. The use of small low hoods at each desk would seem to render the piping system complicated and expensive. Except in very special cases the necessity of an individual hood close at hand is not very great. The bottoms can be made of concrete or wire lath, tile or soapstone, and the hoods should not be more than 18 inches deep. The ducts from the hoods can be made square or rectangular, of the wood or the asbestos compositions mentioned. If of wood they can be grooved and tongued, glued and nailed together and varnished. If made of iron they should be painted with an asphalt or pitchy paint, as "chrysolite" (Solvay Process Co.). Aluminum paint is not found to protect iron as well as has been claimed for it.

Laboratory Desks and Lockers.—So far as the writer's experience goes, the responsibility for their selection lies usually with the architect, and it is common experience that architecture and chemistry do not "mix"; that is, good architectural students are oftentimes deficient in chemistry.

Quartered-oak desks and alberene stone tops seem almost as much out of place amid the fumes and acids of a chemical laboratory as dress suits for the students. Even a casual visitor can not help having a pang of regret to see a fine quartered oak panel ruined by the attack of sulphuric acid or caustic soda. Speaking from wide observation and the experience of others, the writer is convinced there is no better (and in the long run cheaper) material for the tops of ordinary laboratory desks than wood. Tiling is always uneven, lead is untidy and expands but does not contract when heated, glass cracks, and all are cold to the touch. For the tops of laboratory desks or tables the following woods have been found to give good satisfaction: Northern pine, whitewood, cedar and California redwood. These may be finished with equal parts of linseed oil and turpentine, or, better, filled with aniline black made in the pores of the wood, according to the following procedure: Apply to the wood solution one, and after it has dried in, solution two: Solution I., 100 grams aniline hydrochloride, 40 grams salammoniac, dissolved in 650 c.c. of water. Solution II., 100 grams copper sulphate, 50 grams potassium chlorate, dissolved in 650 c.c. of water. Oak, ash, or cypress can not be recommended, the former two because they shrink too much and the last because it is very splintery. If the tops are made of two-inch stuff they can be planed down

from time to time and even turned over, when one surface is too far gone for planing. Such tops have been known to last with constant usage in an organic and analytical laboratory for nearly thirty years. These plank tops should be made of lumber as wide as possible and be carefully jointed and well glued together. When properly done it is rare that the glued joint starts. From some laboratories which the writer has seen it would not seem advisable to build the tops of narrow seven eighths inch floor boards even when fastened to a second seven eighths inch top; the joints open and the boards warp and curl making a very undesirable, uneven surface.

Desk Hardware.—For locking the desks, iron hasps and screw eyes and heavy padlocks have given excellent satisfaction even with freshmen, for twenty-five years' constant use. These locks[8] are bronze throughout, with brass or bronze springs and six secure levers, master-keyed, with changes permitting at least four hundred in a series: they are circular, except for the shackle, and about two and one fourth inches in diameter and cost about a dollar each. They should be oiled annually with a light non-gumming petroleum spindle oil. Padlocks have the advantage over mortise locks, keyed or keyless, in that if they fail to open the screw eye can be cut with a blacksmith's bolt cutter, the padlock removed and the cut screw eye replaced by another. The damage to the desk is nothing compared with that incident to forcing a drawer or hammering the lock loose or off by a punch on the round key-hole standard. They have the additional advantage that they, being laid on their side, in the drawer when not in use, are not exposed to the corrosive action of chemicals spilt upon them. These run down the mortise lock around the bolt and levers and stick them fast. Their sole disadvantage, as against combination locks, lies in the loss of the key. The losing of keys can be largely prevented by requiring the use of key chains attached to the bunch of keys and also by informing the student that they are charged one dollar each if lost. They have the advantage that they are much more easily opened, while if the combination be forgotten the instructor has to search it up in the records. Unless the combination on each lock be changed annually, an elder student, a sophomore, for example, would have access to the desk which he used as a freshman, which is now occupied by another student, a serious disadvantage. The changing of several hundred combinations annually is no trifling task. Hard-wood knobs are to be preferred to metal knobs or handles. The Fogg adjustable ball catch with the ball on the *standing* part of the desk has given excellent service. Iron hinges are apparently as good as brass and are cheaper.

Piping and Drainage.—All pipes and drains should be arranged so that every foot can be easily rendered accessible for inspection and repairs. This can be brought about by the "top system" of pipes and drains on the desks and these connected with the main system under platforms running along one end of the desks. Or the piping can be arranged upon the back of one line of desks and the other line, which is movable, backed up to it. Iron piping should be used as far as possible, the outside being painted with a pitch or asphalt paint. Lead lined pipe instead of lead would seem to be satisfactory for suction. For peaty service waters, black pipe fills up rapidly with zooglea, crenothrix and iron rust. This can be avoided to a large extent by the use of galvanized iron or lead-lined pipe. For drainage the lead-lined or even plain

[8] Made by the Miller Lock Co., Philadelphia, Pa.

wooden troughs kept well painted with thin coats of asphalt have given good satisfaction. They are much to be preferred to lead pipes, which continually give trouble from clogging. In concrete construction the writer has these troughs replaced by trough-like depressions made in the floors and lined with asphalt. Care should be had to make these of sufficient capacity and fall; they are covered with slate or cast-iron slabs. The vertical drains should be constructed of hard baked Akron tile or better yet, chemical pottery, and the joints made with cement or possibly with the same material as the asphalt floors. These vertical drains can either be in the elevator well or in a square space in the wall, it being closed with doors so that they too, are readily accessible. Individual traps and vents are not needed in the various laboratories, but the whole system should be effectively protected by traps in the basement. For sinks the ordinary round stoneware wash bowl may be used. This is made with an overflow, and instead of the usual brass fitting at the bottom a porcelain tube two or three inches long projects from it, carrying eyelets at the top on either side of the bowl. The tube fits down into a piece of lead pipe two feet long which empties into the trough on the back of one line of desks. This lead pipe is supported at the top by the eyelets just mentioned. These pipes can then be easily replaced by the janitor, the services of the plumber not being needed. Each laboratory should be provided with valves so that the steam, water and gas can be shut off from it without disturbing another room. The gas valve should be placed near the exit so that it can be closed nightly and diminish the danger from fire.

Augustus H. Gill
Massachusetts Institute of Technology,
March, 1909

THE PRINCIPLES OF THE CALCULUS AS APPLIED IN THE TECHNICAL COURSES OFFERED AT THE UNIVERSITY OF ILLINOIS

Considerable discussion has been aroused in mathematical and engineering circles by the publication in Science of the papers presented at the symposium on mathematics for engineering students held in Chicago at the time of the joint meeting of the American Mathematical Society and the American Association for the Advancement of Science. The committee appointed soon after this meeting is now formulating a course in mathematics intended primarily for engineering students, and their outline will undoubtedly be accepted as a syllabus of the mathematics required by students in technical courses throughout the country. In this connection it may be suggested that some notions as to the contents of such a course might be obtained from an investigation of the various technical courses offered at some university maintaining a school of technology of recognized standing. It would be of interest to know what principles, say of the calculus, are actually used, and how often, in a single complete course or group of technical courses. Data on the relative frequency with which these principles are used might suggest the amount of emphasis to be accorded each in a course of mathematics for engineers. On the other hand, such data should also suggest to the teacher of mathematics those principles which, though not emphasized in the application, should constitute an important part of any well-rounded course in the calculus. The gaps to be thus filled become apparent on investigating what principles of the calculus are emphasized throughout the technical courses actually offered.

In this investigation I have considered the technical courses as offered in the college of engineering of the University of

Illinois and have made two assumptions which no doubt hold elsewhere.

First. Text-book work predominates throughout, and hence the texts used furnish a rational basis from which to judge both the kinds of principles used and their frequency of application.

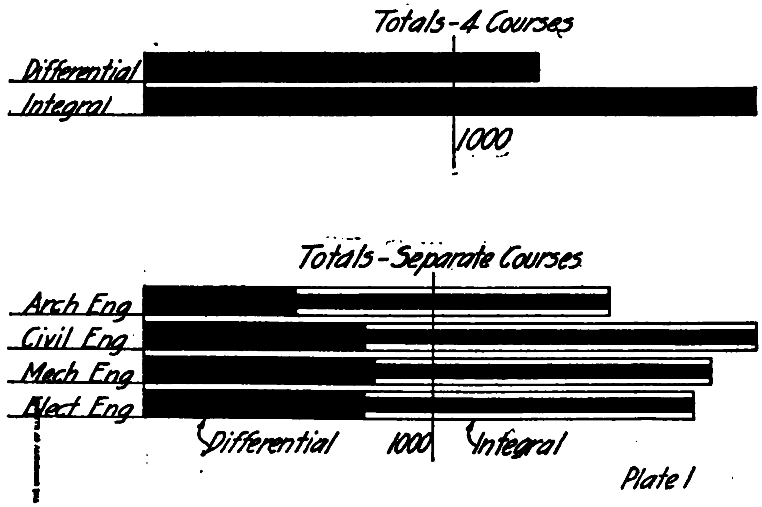


Plate I

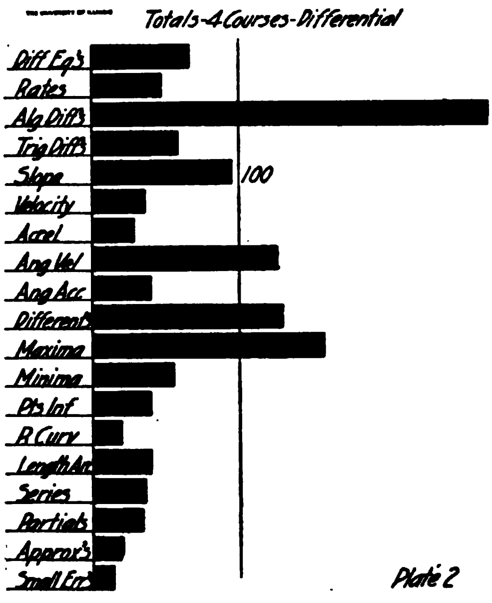
Second. The principles, as applied in these texts, are used as often in the lectures and problems given for solution as in the texts themselves.

The list of authors of the texts studied includes the names of men connected with at least a dozen technical schools of recognized merit besides those of men at Illinois. The emphasis placed on the principles of the calculus will, necessarily, vary with the instructors in charge of the different courses; yet, as giving an average, the above assumptions seem reasonably accurate.

Any investigation of this nature will undoubtedly show that algebra and trigonometry are used much oftener than the calculus; in fact, in the comparison of numbers it would seem that the calculus plays but a minor rôle. In enumerating the principles of the calculus four complete courses were investigated. These are architectural, civil, mechanical and electrical engineering. Similar courses offered, such as municipal and sanitary, railway, civil and others, furnish results in every way analogous to those above mentioned. The architectural engineering course is included because in it, as offered at Illinois, are included those courses which form the backbone of all the subjects which make use of the calculus. These courses vary all the way from that in architecture, where mechanics is taught without a course in the calculus, to those in which the mathematics used furnishes the most serious difficulties met. If then a summary is made of the principles used in the four courses mentioned we have the results, as shown in Plate 1. This shows the minimum number of times a student in any of the courses listed might reasonably expect to encounter the various principles of the differential and integral calculus. Plate 1 gives us quantitative results; a qualitative analysis is given in Plates 2 and 3.

Concerning the notions of the differential calculus used it can be said that the differentiations, both algebraic and trigonomet-

ric, are almost always of the simpler sorts; in fact, as compared with algebra employed, they are very easy. Difficult differentiations occur rarely, while the trigonometric are usually limited to combinations involving sines and cosines.

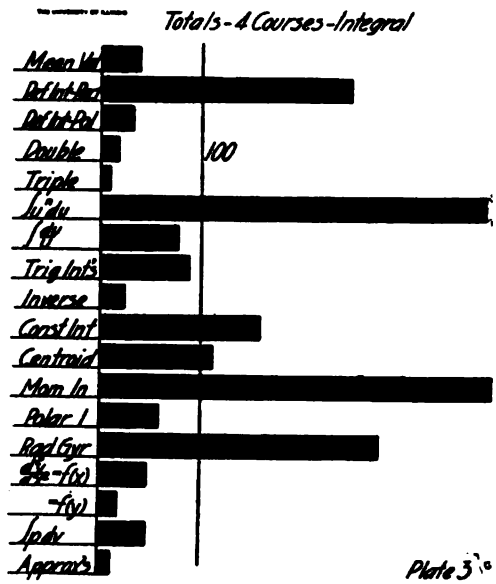


The use of differentials almost invariably brings in the notion of infinitesimals, and it is in this connection that the instructor of mathematics in preparing the future engineer can do an excellent work in giving clear notions of the differential, which need in no wise antagonize the use of the infinitesimal.

The engineering texts are certainly addicted to a rather loose use of the notion of the derivative curves corresponding to the elastic curve for concentrated loadings. A common tangent to these elastic curves at points of discontinuity of the derivative curves is frequently mentioned, and quite erroneously.

Increments and differentials are often used quite synonymously, limits are rarely mentioned, though understood to exist throughout. The duty of the mathematician is clear here, but rigor should in every case add to clearness of concept.

The subject of maxima and minima is handled without the aid of the second derivative, the nature of the problem and result being sufficient in almost every case



for the determination of the complete solution. Maxima and minima are often found when no first derivative is equated to zero; in fact, many cases arise where the notions exist quite sub rosa, because rigid conditions for maxima and minima can, of necessity, exist but approximately. Relative maxima and minima are emphasized and lead to a term such as maximum maximorum. It might be well for the instructor of mathematics to emphasize this feature more in his teaching. Maxima and minima are often solved from the standpoint of algebra and trigonometry.

The series found are usually simple in construction and the question of their convergence is mentioned in but a single text.

The integrals used in almost all cases arise as a consequence of the summation

process, as would naturally be expected, and the integral is most frequently that of a power of the variable or function. Double and triple integrals occur but rarely, not but what they could be used

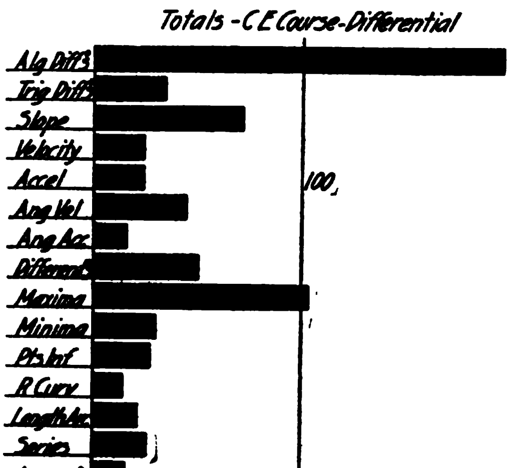


Plate 4

much oftener—but they aren't. The integrals found are simple and the trigonometric are usually limited to combinations of sines and cosines.

The symbol of summation occurs frequently, while the limit of the same is rarely mentioned.

The constant of integration quite often composes the greater part of the indefinite integral, in both size and importance.

Calculus notions, such as moment of inertia, centroid and radius of gyration, occur so frequently that there are portions of certain courses which use very little else in the way of calculus. The question may be raised as to whether these should be classified as principles of the calculus or of mechanics, and the answer to this is that the various texts in the technical subjects assume that the student has learned them in the study of the calculus as a prerequisite.

The principle of mean value as used to find mean pressures, forces, etc., is restricted to the M.E. and E.E. courses.

The limits of the definite integrals used are generally quite apparent from the nature of the problem. The mathematician may well learn a lesson here in the art of making his problems both practical and concrete.

A comparison of Plates 4 and 5 will show that the matter of partial differentiation is one in which the mechanical engineer alone seems to be interested. In this connection it might also be mentioned that the principle of exact or inexact differentials, otherwise known as the integrability condition, plays quite an important and definite part in certain discussions, and that it is deserving of more attention than it receives at the hands of the authors of texts in the calculus.

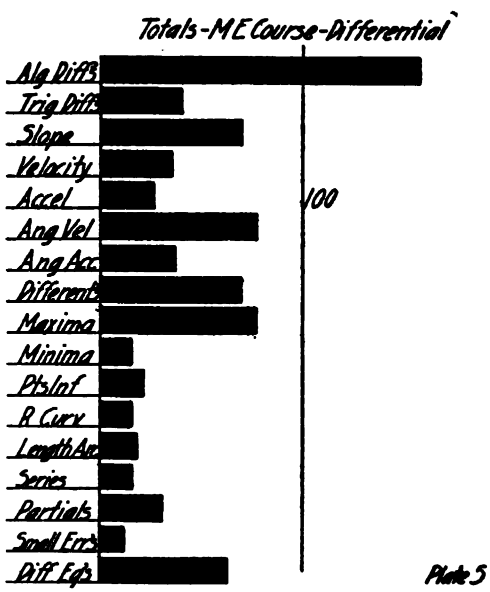


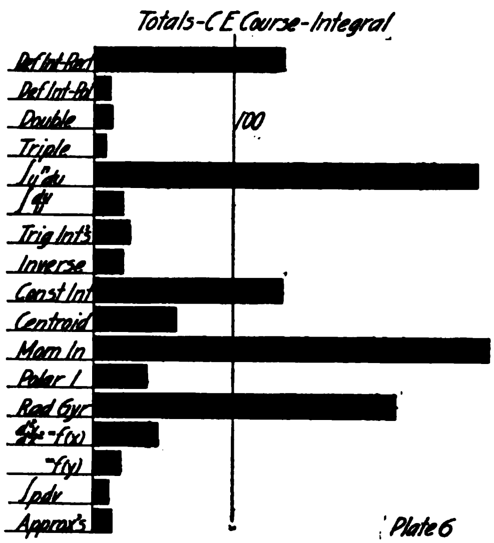
Plate 5

It will also be seen that the subject of angular velocities and accelerations should receive more attention than is usually given to it.

The study of differential equations, espe-

cially from the standpoint of their interpretation, is a feature of the M.E. and E.E. courses.

Plates 6 and 7 seem to indicate that the M.E. course requires a more general use

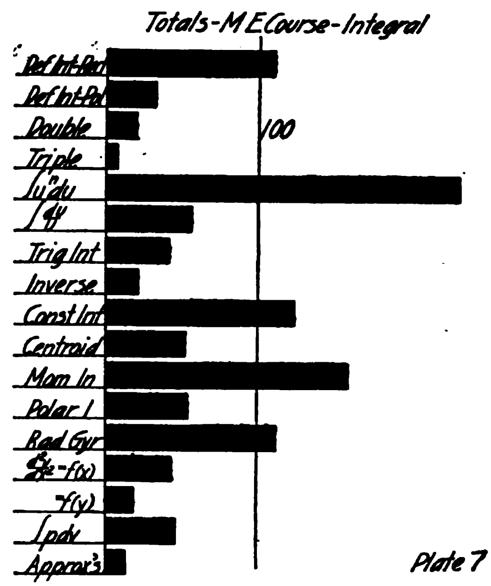


of the principles of the integral calculus than the C.E. course.

If we look for such articles as the evaluation of indeterminate forms, complicated integrals to be broken up into partial fractions before integrating, long reduction formulas, fancy substitutions, forms of remainders, order of contact, envelopes, subtangents and the like, we won't find them. Many curves are used and should be studied more for their properties than they are, one reason why they are not being the fact that the equations of so many of the curves which arise can at best be found only empirically.

It might seem that the matter of approximations is neglected in the enumeration because of the fact that so many approximations must necessarily occur in engineering practise; but in the list of those enumerated none were included which did not have a strong flavor of the calculus, which fact excluded many often listed under the head of approximate integrations, such as the use of Simpson's rule and the like.

Can we learn any general lessons from the results of the investigation? Easily. It is apparent to even the casual observer that the subject which stands out most prominently is that of the formulation of the definite integral with its limits. Here it is a question of whether or not the student can think mathematically, whether he is alive to the situation and grasps the problem before him, and whether he can express existing conditions in mathematical language. He should know the fundamental principle of the integral calculus well, and should have a check on his work wherever possible. A planimeter should find its place in the same class-room with the slide rule, and both should be used as early as possible for checking up results.



It is not sufficient to have theory only, for engineering by its very nature calls for results. The notions of the calculus are not used blindly, each has its specific ap-

plication, and the student must at all times be alive to the situation before him. It is the province of the mathematician to point out the limitations placed upon the use of the principles, not in the spirit of criticism, but of mutual help; for approximations must come into the work of the engineer, and a lot of the calculus used must be of the rough and ready sort. If the treatment can not be rigorous at all times it is the province of the mathematician to point out just how far the engineer may go and how near ideal conditions he is working—not to suggest that the whole structure is built on an insecure foundation. The engineer and mathematician can help one another, on the side of the engineer in presenting live problems in which the mathematician should be interested, and on the side of the mathematician in helping put the whole subject on a safe foundation; both working with the spirit of mutual assistance toward the doing of things worth while, not only to the engineer, but also to the mathematician.

Ernest W. Ponzer

SCIENTIFIC NOTES AND NEWS

The Palmer Physical Laboratory of Princeton University will be formally opened on the evening of October 22, when Dr. Elihu Thomson will give the principal address. The American Physical Society will meet at Princeton on the following day, and in the evening there will be a reception at the Nassau Club.

Dr. T. W. Richards, professor of chemistry at Harvard University, has been given the honorary degree of doctor of philosophy by the Czech University of Prague.

The British Institute of Marine Engineers has awarded the Denny gold medal to Mr. W. P. Durtnall, for a paper on the generation and electrical transmission of power.

It is proposed to celebrate the fortieth year of university teaching of Professor Enrico H. Giglioni, of Florence, by presenting him with an album containing the autograph signatures of zoologists and anthropologists throughout the world. Those who wish to join in this testimonial are requested to send their autograph to Dr. Enrico Balducci, Via Romana 19, Florence.

Dr. Josef von Hepperger, professor of astronomy at Vienna, has been appointed director of the University Observatory.

The trustees of the Lincoln State School and Colony, at Lincoln, Ill., have provided for the establishment of a department of clinical psychology in the state institution for the feeble-minded. Dr. Edmund B. Huey, who has spent the past year in clinical study in Paris, on leave from the University of Pittsburgh, has been appointed to take charge of the new department, and has begun his work at Lincoln.

Professor R. S. Tarr, of the department of geology of Cornell University, has sailed for Europe, where he will spend a year on sabbatical leave.

News has been received from Dr. T. G. Longstaff to the effect that he has arrived at Leh, in Ladak, after having connected the Tarim river with the Saichar glacier.

Mr. Shackleton has left England on a continental tour, and is to tell the story of his Antarctic expedition in the principal cities of Europe. On October 9 he was to be the guest of the Royal Geographical Society at Copenhagen. He will proceed to Stockholm and Christiania, and afterwards will visit Brussels, Antwerp, Berlin, Rome, Vienna and Paris. In March he leaves England for America on an extended tour.

The program for the meeting of the American Mathematical Society on Saturday, October 30, will include a paper by Professor Carl Runge, Kaiser Wilhelm professor at Columbia University, on "A hydrodynamic problem treated graphically."

The faculty of fine arts of Columbia University announces a series of four lectures to be given on Monday afternoons at 4:10 o'clock in Havemeyer Hall, by Charles E. Pellew,

E.M., adjunct professor of chemistry, upon the subject "Practical Dyeing," as follows:

October 18—"Dyeing of Cotton with Modern Dye-stuffs."

October 25—"Tied and Dyed Work."

November 8—"Dyeing and Adulteration of Natural Silk."

November 15—"Manufacture and Dyeing of Artificial and Imitation Silk."

THE first Hunterian lecture of the Hunterian Society was delivered on October 13 at the London Institute by Dr. Sidney Martin, who discussed certain infective processes in the intestine and their results and treatment.

A COURSE of twelve free lectures under the Swiney trust will be given at the Victoria and Albert Museum, beginning November 6, by Dr. T. J. Jehu, on "The History of Northwest Europe during Tertiary Times."

M. J. A. FRAISSINET, secretary of the Paris Observatory, died on August 29, in his sixty-third year.

DR. GEORGE EDWARD POST, for many years head of the Medical College at Beirut, the author of text-books in Arabic on biological subjects, has died at the age of seventy-one years.

THE second International Congress for the Repression of Adulteration in Food, Chemical Products, etc., to be held in Paris on October 17–24, will include sections as follows: (1) wines, alcohols, syrups, liquors, beer, cider; (2) farinaceous foods, baking, pastries, meat and other pastes, spiced confectionery; (3) cocoa, chocolate, confectionery, honey, sugar and sugar candy; (4) vinegar, mustard, pepper, spices, tea, coffee, chicory; (5) butter, milk, cheese, eggs; (6) lard and edible fats, margarine, provisions preserved in oil, bacon, sausages and pork products, salted provisions and canned and bottled goods; (7) drugs, chemical products, essential oils, etc.; (8) mineral water (medicinal) aerated waters, ice.

IT is stated in *Nature* that an Italian National League against malaria has been formed, and the first meeting has been held at Milan. The inaugural address was by Professor Baccelli, and the following communications have been promised: the present state of knowledge in regard to malaria, by Professor Bordoni-Uffreduzzi; prophylaxis against malaria, by Professor Castellino; the pathology of malaria, by Professor Golgi; some questions relating to the pathology and treatment of malaria, by Professor Grassi; little known abortive forms of malaria, by Professor Queirolo.

IT is stated in the *Nation* that the Russian Ministry of Marine is equipping three expeditions to be sent out in the year 1910 to explore the coasts of the Arctic Ocean. One steamship will go from Vladivostok to find its way along the coast of northeast Siberia from Bering Strait to the mouth of the Lena, and is to spend from three to four years in this task. A second expedition will visit the Taimyr Peninsula for hydrographical and topographical investigations. The third expedition, which, like the last, starts from St. Petersburg early in 1910, will follow the land route to the Taimyr Peninsula, and will study particularly the courses of the rivers and the geology, climate and meteorology of the country, establishing local meteorological stations.

AT the New York November meeting of the American Society of Mechanical Engineers, to be held on the ninth in the Engineering Societies Building, 29 West 39th Street, at 8:15 o'clock, there will be two papers presented. One by Professor Gaetano Lanza and Lawrence S. Smith, of the Massachusetts Institute of Technology, on "Reinforced Concrete Beams," and the other by Professor Walter Rautenstrauch, of Columbia University, on "Stresses in Curved Machine Members." The paper on reinforced concrete beams is the same as that given at the Boston meeting of the society on October 20. It compares the results of tests upon full-sized beams made at the Massachusetts Institute of Technology and the University of Illinois with three different theories of beams of this type. The paper on stresses in curved machine members outlines the method of procedure for the design of principal sections of hooks, punch and shear frames and other curved machine parts. Experimental results are submitted in support of the theory presented.

The following lectures will be given in the department of chemistry, of the College of the City of New York:

November 5—"The Latent Photographic Image," by Professor W. D. Bancroft, professor of physical chemistry, Cornell University.

November 19—"The Warfare of the Future," by Mr. Hudson Maxim.

December 3—"Explosions in Coal Mines," by Dr. J. A. Holmes, chief of the Testing Bureau, U. S. Geological Survey.

March 11—"Coal Tar Colors," by Professor I. W. Fay, professor of chemistry, Brooklyn Polytechnic Institute.

March 18—"Enzyme Action," by Dr. P. A. Levene, chief of the division of chemistry, Rockefeller Research Laboratory.

April 8—"Chemical Equilibrium," by Professor Arthur E. Hill, professor of chemistry, New York University.

April 15—"Chemistry of Digestion," by Professor W. J. Gies, professor of physiological chemistry, College of Physicians and Surgeons.

April 22—"Conservation of the Waters of the State," by Dr. Ernst Lederle, former chairman of the Board of Health, and sanitary engineer.

During the year 1909–10 the series of lectures given by Cornell University in cooperation with the New York State Department of Health upon the subject of "Sanitary Science and Public Health" will be continued. Following is a list of the lectures for the first term:

October 5—President Schurman: Introductory lecture, outlining the field and subject matter of the course.

October 7—Dr. G. W. Goler, health officer, Rochester: The history of therapeutics, showing the barbarism of ancient methods of hygiene and medical knowledge.

October 12, 14—Dr. E. H. Porter, state commissioner of health: Public health administration in general; state control of certain specified diseases and insanitary conditions.

October 19, 21, 26, 28—Professor J. W. Jenks: Social problems in their relation to public health.

November 2, 4, 9, 11—Professor W. F. Willcox: Prolongation of human life; the classification of causes of death; marriage and divorce; the birth rate.

November 16, 18—Professor F. A. Fetter: Philanthropy and public health.

November 23—R. A. Pearson, State Commissioner of Agriculture: The relation of rural communities to the public health.

November 30, December 2—A. H. Seymour, secretary of the state department of health: The development of the public health law and the state control of health; provisions of the public health law as applied to specific regulation.

December 7—Professor S. H. Gage: The application of the laws of heredity to public health.

December 9—Professor E. B. Titchener: The influence of the mind upon private and public health.

December 14—F. L. Hoffman, statistician of the Prudential Insurance Company: Problems of life and health in industry.

December 16—Dr. W. L. Russell: Insanity and public health.

December 21—Dr. H. J. Webber: Betterment of agricultural conditions.

January 6—Dr. B. R. Wakeman: Modern surgery with reference to the prolongation of human life.

January 11, 13—Director V. A. Moore: The nature of disease; micro-organisms and their relation to disease.

The *Scottish Geographical Journal* gives some details in regard to Captain Scott's proposed Antarctic expedition. The main object would be to attempt to reach the pole, and with this object two bases would be established, one at McMurdo Sound, and one if possible in King Edward VII. Land. The attack on the pole would be made from one or other of these bases according to circumstances. Three separate means of traction would be employed—ponies, dogs and motor-sledges. The experience gained by Mr. Shackleton's party would be utilized as far as possible in determining the special circumstances in which each would be employed. Thus, ponies proved suitable for traction over the surface of the barrier, but not for glacial work, for which dogs would be used. Although Mr. Shackleton's motor-car did not prove a success on the soft snow of the barrier, much is hoped of a new type of motor-sledge with which experiments have been recently made. Food would therefore be transported to the foot of the glacier either by ponies or by motor-sledges, while the final dash to the pole, once the plateau had been reached, would be made with the help of dogs.

The scientific objects of the expedition may be briefly stated as follows: 1. Geographical.—To explore King Edward's Land, to throw further light on the nature and extent of the great Barrier ice formation, and to continue the survey of the high mountainous region of Victoria Land. 2. Geological.—To examine the entirely unknown region of King Edward's Land and continue the survey of the rocks of Victoria Land. 3. Meteorological.—To obtain synchronous observations at two fixed stations as well as the weather records of sledge journeys. 4. Magnetic.—To duplicate the records of the elements made by the *Discovery* expedition with magnetographs. The comparison should throw important light on secular changes. 5. Miscellaneous.—In addition, attention will be paid to the study of marine biology at both stations and in the ship, and the examination of physical phenomena will be continued. The plan which has been outlined to secure the main object of the expedition, together with subsidiary plans for the complete exploration of the region of King Edward VII. Land, will necessitate the establishment of a strong party of men at the winter stations and a more ample equipment than has hitherto been taken. It follows that the ship in which the expedition embarks must be suitable in size as well as strong enough to enter the heavy pack ice likely to be met with in the region of King Edward VII. Land. These considerations prevent the full realization of the project under a total estimated expenditure of £40,000. The steamship *Terra Nova,* which served as a relief ship in the *Discovery* expedition, has been purchased for the expedition.

UNIVERSITY AND EDUCATIONAL NEWS

Mr. Andrew Carnegie has subscribed $100,000 to McGill University as a part of the general fund of $2,000,000 which friends of the university are trying to raise.

The University of California has purchased 250 acres of land adjoining the campus. This land comprises the inner portion of Strawberry Cañon, running to the crest of a ridge of the Berkeley Hills.

The John Morley Chemical Laboratories of Manchester University were opened on October 4 by Sir Henry Roscoe, who was for many years the professor of chemistry of the university. Lord Morley, the chancellor of the university, in whose honor the laboratories are named, made the principal address.

At Princeton University Dr. E. P. Adams, assistant professor of physics, and Dr. L. P. Eisenhart, instructor in mathematics, have been promoted to professorships.

Dr. Ralph Edward Sheldon, associate in anatomy in the University of Chicago, has been appointed as assistant professor of anatomy, in charge of histology, embryology and neurology, in the University of Pittsburgh Medical School.

At Cornell University H. E. Howe and H. O. Taylor have been appointed instructors in physics.

At Wellesley College, Miss Louise S. McDowell has been appointed instructor in physics.

At Birmingham University the chair of zoology, rendered vacant by the death of Professor T. W. Bridge, F.R.S., has been filled by the election of Dr. Frederick William Gamble, F.R.S., and Professor Peter Thompson, of King's College, London, has been appointed professor of anatomy in the place of Professor Arthur Robinson.

Professor George A. Gibson, of the Glasgow and West of Scotland Technical College, has been elected to the chair of mathematics at the University of Glasgow.

DISCUSSION AND CORRESPONDENCE

A NEED OF INTERNATIONAL CONGRESSES

In Science for September 17 appeared the very interesting account of the proceedings of the Seventh International Congress of Applied Chemistry, held in London in May, 1909. This account is impressive in many ways, and especially in one, of which, possibly, the author, Professor Baskerville, was not conscious. The report throws into strong relief the great

need of such international gatherings—an international language, in which the proceedings may be held, in order that all the participants may understand fully and immediately what is being done.

It is stated in the report that distinguished men of chemical science were present from more than twenty nations, yet the business of the congress was transacted in four languages only, English, French, German and Italian. After the name of each speaker is given the language used—confined, of course, to the four named. It is a fair question to ask if those present from Russia, Spain, Sweden, China, Japan and other lands, understood all or any of the speeches; or if, indeed, even some of those speaking in one of the languages named, understood the remarks of their colleagues using some of the others. How many of the delegates were debarred from participating in the debates because they did not know, or were unskilled in the use of the official languages, and how many of those present were compelled to await the publication of the proceedings before being able to digest them and were compelled, even then, to rely upon the work of a translator? How much valuable time was lost in interpreting the speeches or in repetition of the same remarks in four different tongues?

The Societa Fotografica Italiana presented to the Section of Photochemistry an album of photogravures, showing the effects of the great Messina earthquake, and it was necessary to print the text in four languages, and doubtless this course was also followed in publishing the *Proceedings* of the congress. Does this not seem to entail much labor and expense which science should be able to find means to avoid?

Dr. Wiley, in urging upon the congress the acceptance of the invitation of the United States government to hold the next meeting in America, voiced his appreciation of the language difficulty when enlarging upon the number of foreign-born citizens of the United States and in assuring the delegates that they could count upon being welcomed in their own tongue; though, apparently, he did not venture to promise them that they would be able to understand the proceedings of the congress itself.

These and other items appearing in Professor Baskerville's report show plainly how the diversity of language still stands like a menacing angel with drawn sword at the portal of all international gatherings, threatening with misunderstanding and difficulty all who seek to enter. How long will civilized humanity, and particularly scientific humanity, upon which depends the progress of the race, submit to such humiliating conditions?

The question presses harder to-day than ever before, as modern progress makes international communication more frequent and necessary. Surely science, which has leveled so many obstacles before advancing mankind, must soon give its serious attention to this one, which looms so large, and more especially so, because the solution of the difficulty is so obvious. This solution is the world-wide adoption of an *international* language—a second language which all will learn in addition to their natural tongue, and by means of which they can communicate with all civilized men. What language to select for the purpose is, however, not so obvious and here the difficulties arise. It is not necessary to enter here into a discussion of these; Dr. Kellerman, in an illuminating article in the *Popular Science Monthly* for September, has taken up the whole matter most thoroughly and it would appear that the conclusion reached in that article, viz., the official adoption of the artificial international auxiliary language Esperanto, a living tongue already largely used for the purposes in view, is the logical one. This language seems to be making good its claim of easy acquisition, combined with power of euphonious and clear expression, and being widely disseminated already, seems to await only general official recognition by governments and prominent international associations to prove the actual solution of the troublesome question.

That this is believed by many scientific bodies is shown by the fact that they have already taken the step indicated and made Esperanto their official language. The Pan-

American Scientific Congress at Santiago, Chile, in January, 1909, with official delegates from twenty American governments present, not only took such action, but, in addition, adopted on January 4 the following resolution:

Considering, that a neutral auxiliary international language is necessary, and observing that the idiom Esperanto fulfils the requirements, that it is already sufficiently widespread throughout the world, and that official propaganda alone is lacking:

1. That the First Pan-American Scientific Congress decide to express to the American governments the pleasure with which it would view the call for a congress to which would come official representatives of all civilized countries, with the purpose of solving the problem of the adoption of a neutral international auxiliary idiom; and

2. It agrees to urge upon the government of the United States of North America that, under its grand auspices this desire of the Scientific Congress may be effected.

The next Congress of Applied Chemistry meets in America in 1912, the same year in which the next Pan-American Scientific Congress will gather in the same country. May we not hope that before that time the expressed desire of the latter will be realized, and that, led by the United States, as suggested, the governments of the nations will place in the possession of every man the instrument by which he can make himself understood by every other man?

At Washington, in the summer of 1910, will meet still another international body, the Sixth Annual Esperanto Congress, and if the experience of recent preceding years is duplicated, there will gather in attendance delegates from thirty or more nations, speaking as many languages; but, in great contrast to the congress, the report of which inspired these remarks, the proceedings will be in only one language—Esperanto. No time will be wasted in translation or repetition and *all* the members will understand *everything* that is done, *at the time*, and will be able to discuss freely all the matters presented. Every international gathering and association can do the same, if it will, instead of continuing to struggle with the archaic system now in vogue.

Surely all our scientific brethren will soon recognize this fact and a new step upward in human progress will have been achieved.

J. D. HAILMAN

PITTSBURGH,
September 22, 1909

THEORY AND HYPOTHESIS IN GEOLOGY

THE importance of hypothesis and of theory in geological research, as indeed in every other branch of learning, can not be over-estimated. Concrete facts are valuable, and their observation and accumulation are indispensable, but, in pure science, they are of worth chiefly in so far as they are available in explaining the cause of the phenomena for which they stand. The purpose of such science is to ascertain why and under what circumstances present effects were produced. Every hypothesis and every theory is therefore an attempt to expound the relations between cause, condition and effect.

Granting that observation, as far as pursued, has been correct, there are still many reasons for disagreement in theories. Scantiness and multiplicity of data may lead, respectively, to error of interpretation and to variety of inference. In both events, the personal equation is at a maximum. Again, lack of experience—that is, want of a thorough acquaintance with all the facts, not only in the specific case which serves as a foundation for the theory, but also in all similar occurrences—may result in diversity of opinion. Very common, too, has been the tendency to exaggerate the importance of some one particular factor or cause. Consider, for example, the numerous efforts to account for a glacial epoch. This fallacy is due partly to the personal equation, partly to a failure to discern all the premises, and partly to an innate desire for simplicity, a craving which induces the theorist to assign but one cause to a given phenomenon.

The misconception of the need for unity of cause may be an outgrowth from the doctrine of uniformity. But uniformity is not synonymous with simplicity, any more than complexity is synonymous with chaos. Nature is orderly; its realms are everywhere subject to

unchanging law; yet nature is intricate, profoundly intricate, and its processes interact beyond man's faculty of perception.

How the idea of complexity in nature is important may best be seen in its application to cause, condition and effect, the three essential topics of every theory. According to this conception, one effect may be the result of several causes. For instance, as Professor Crosby pointed out some years ago,[1] eskers may be partly of subglacial and partly of superglacial origin, and a single esker may be both in different portions of its course. The hydrocarbons, in their various occurrences, do not always satisfy the view entertained by some geologists, that they have had an organic source. Hence it is probable that they (the hydrocarbons) are like effects to be ascribed to different causes. Moreover, to say that, inasmuch as we observe a certain deposit to be forming to-day by a certain process, "it is therefore a legitimate theory that all similar deposits have the same origin,"[2] is unsafe reasoning. Because limestone is now in the making as an organic deposit, *all* limestone has not necessarily been so derived. Multiplicity of causes, then, must be taken into consideration by the theorist.

On the other hand, while the cause may be single, the conditions under which it acts may be so various that the effects are manifold. If the circumstances of origin are widely different, interpretation of the results is not so difficult as it is when these conditions are hard to discriminate. Thus, a theory of wind-worn sand should have regard for the composition of the sand; the size, weight, specific gravity, hardness and cleavage of the grains; and the prevailing wind velocity. So, too, any exposition of the origin of phenocrysts in igneous rocks should be developed with due heed for variations in the acidity and basicity of magma and of country rock. Consequently, multiplicity of conditions is also to be allowed for in elaborating a theory.

[1] W. O. Crosby, "Origin of Eskers," *Am. Geol.*, XXX., p. 2.

[2] H. L. Fairchild, "Geology under the New Hypothesis of Earth-origin," *Am. Geol.*, XXXIII., p. 107.

Thus, in the intricate system of nature, *similar* products may be the outcome of *different* causes, and *unlike* products may result from *one* cause, in each case the causes working under varied conditions. Although there are many other relations between cause, condition and effect, these two are especially emphasized here because they are most easily overlooked.

Summarizing—theory and hypothesis too often suffer from the mistake, first, of overrating the importance of some one particular cause or condition, and, second, of extending, more broadly than is legitimate, the application of this factor. These fallacies are in large part due to a failure to realize the extreme complexity of the relations between cause, condition and effect.

To avoid misunderstanding and to give a theory real value, we must assign to it definite limits, beyond which criticism should not reach. Be discreet in generalization, is good counsel.

Fred. H. Lahee
Harvard University,
January 4, 1909

THE BEHAVIOR OF A SNAKE

Several years ago, while Mr. Lester and I were sauntering along a country road near Newnan, Ga., a commotion was heard in the dry leaves along the side of the road. On quietly entering the underbush, it was noticed that the noise was caused by a struggle between a coach-whip snake (*Zamiens flagellum flagellum* Shaw) and a lizard that was unknown to me. The snake was about four feet long; the lizard less than a foot. They were not fighting; the snake was trying to make a meal of the unmanageable lizard. Frequently the lizard escaped from the snake. Then would follow a chase resulting in the recapture of the lizard. The snake invariably caught the lizard by the body. I knew that, if the snake were to capture the lizard by the tail, the lizard would break off the tail and escape. The snake, behaving as though aware of this, attracted my attention and caused me to remain and study its movements.

So intent was the snake upon mastering the lizard, that it paid no attention to me, standing there as quietly as a statue. Several times the pursued lizard and the chasing snake passed across my feet. At one time, the lizard, on escaping from the snake, darted up a tall tree. The snake followed. Here the four articulated limbs of the former gave it a decided advantage. After darting up the tree for a short distance, the lizard paused and glanced backward. As soon as the snake had approached quite near, the lizard darted ahead a short distance and then again paused and glanced backward. These reciprocal movements were repeated several times. Then, all of a sudden, the snake dropped to the ground. The lizard continued to gaze downward. About a foot from the tree upon which the lizard was resting, head downward, there stood another tree. Spirally up this trunk the snake quietly and slowly climbed, until it was a few inches above the level of the lizard. The unsuspecting lizard was scrutinizingly gazing downward. Quietly and quickly the snake extended the front portion of its body, and, with a sudden dart of the head, knocked the lizard to the ground. Before the latter had time to recover from the effect of the unexpected blow, the snake had dropped to the ground and recaptured it. The lizard was not yet conquered; but this article is concerned only with the behavior up to this point.

This behavior puzzled me for a number of years. I was reluctant to call it an exhibition of logical judgment; yet it seemed entirely too complex to be regarded as reflex action and too individualistic to be considered instinctive, in the ordinary sense. From the nature of the case, tropisms, as defined by Loeb, are out of the question. Nor could it be considered a "trial and error" response; for there is no series of errors followed by a blundering into a solution and a gradual "stamping in" of the appropriate response.

The problem that confronted this snake was how to overpower that lizard. Until the lizard climbed the tree, the follow-the-stimulus movements, which were either instincts or habits, were sufficient to cause the capture of the lizard: but, the moment the latter ascended the trunk of that tree, those movements, unmodified, were inadequate. Suddenly the behavior of the snake changed. It paused, then immediately met the situation with a response which was a special modification to suit a special circumstance; and this is what we mean by a practical judgment.

I am well aware that some will call this an anecdote and desire to throw it out of court, because it was not conducted in a laboratory, under laboratory conditions, and because we do not know the whole past history of the snake and its ancestors. Nevertheless, I am coming more and more to believe that ignoring the spontaneous behavior of animals in their natural environments hinders rather than helps the solution of the problems of animal behavior; for, it is in just these situations that the animals are apt to be resourceful. More caution is needed to interpret behavior in the open than under laboratory control; but the difficulties of the task furnish no excuse for avoiding it. I am a stanch advocate of laboratory work; but, at the same time, I feel that data derived from accurate field work are of greater value than many seem to think. Accurate observations made, by trained observers, in the field furnish us with stubborn facts that should not be ignored; they need to be interpreted in an unprejudiced manner. Laboratory work and field work should go hand in hand.

C. H. Turner

Summer High School,
St. Louis, Mo.,
April 29, 1909

QUOTATIONS

INCORPORATED BENEFACTORS

Benefactors die; universities abide. At least, that has been the case in the past. But in this age of organization, benefactors have learned to perpetuate themselves as corporations. And we now have institutions chartered by acts of congress to disburse for educational purposes the charities of millionaires. The rich philanthropist, who objectifies himself in such a benevolent corporation, of

course, names the trustees; and subsequent vacancies in the board are filled by cooptation. This is a new species of corporation; but the two or three already organized hold large funds, which are likely to be greatly augmented in the future. And there is no limit to the number of such corporations, except the limit to the number of persons who possess wealth and desire to distribute it in this fashion.

I can not but think that these corporations create a new and dangerous situation for the independent and privately endowed universities. Just in proportion as these are supported by those benevolent corporations is their center of gravity thrown outside themselves. It is no longer a case of a rich man giving his money, going his way (eventually dying), and leaving the university free to manage its own affairs. The purse strings are now controlled by an immortal power, which makes it its business to investigate and supervise, and which lays down conditions that the university must accept if it is to receive grants of money. An irresponsible, self-perpetuating board, whose business is to dispense money, necessarily tends to look at every question from the pecuniary point of view; it wants its money's worth; it demands immediate and tangible results. Will not its large powers and enormous influence in relation to the institutions dependent upon it tend to develop in it an attitude of patronage and a habit of meddling? The very ambition of such a corporation to reform educational abuses is itself a source of danger. Men are not constituted educational reformers by having millions to spend. And, indeed, an irresponsible, self-perpetuating board of this sort may become a real menace to the best interests of the higher education. In the fancied interests of capital, or religion, or of education itself, it may galvanize the intellectual life of the institution it undertakes to foster.

A board of this kind should be answerable to the public, like the regents of a state university. Or, better still, let the millionaire trust the boards of trustees of colleges and universities and give them outright the capital he intends to devote to educational purposes. I believe that in all cases this plan would be best for education and best for the public interest. I make no exception of the Carnegie Foundation for the Advancement of Teaching, to which Mr. Carnegie has given such large endowment for the pensioning of professors in the colleges, technical schools and universities of the United States and Canada. And I certainly speak with no prejudice, as I regard that endowment as the best thing any benefactor has ever done for higher education in America, and I have myself the honor of being one of the trustees. But I look with concern and anxiety on the influence of such corporations on the free and independent life of our institutions of learning and research.—President Jacob G. Schurman, of Cornell University, in an address before the National Association of State Universities.

SCIENTIFIC BOOKS

The Absorption Spectra of Solutions. By Harry C. Jones and John A. Anderson. Publication No. 110, Carnegie Institution, Washington, D. C. 1909.[1]

This investigation of absorption spectra represents another chapter in that study of solutions, to which Professor Jones and his coworkers have so indefatigably applied themselves. Here, as before, the guiding idea has been to obtain evidence for or against the existence of *hydrates,* or more generally, of *solvates* in solution.

To investigate a system in this way, that is, by observing the effect produced by the system upon light which has passed through it, has one decided advantage. It does not in any way disturb the state of the system. When we shall understand more thoroughly the mechanism of this absorption, such a method may become not only a very rapid, but also a very accurate and elegant means of analysis. Even in our present deep ignorance in regard to this phenomenon it can often furnish us important information, as the authors of the monograph under discussion have amply demonstrated.

[1] A somewhat abridged account of this investigation has appeared in the March and April numbers of the *American Chemical Journal* of this year (1909).

The principle which underlies the whole research is that the absorption spectrum of a solution consists simply of the superposed absorption spectra of all the molecular species present in the solution. In a solution of even a single solute there may be a large number of these molecular species, namely, ions, undissociated molecules, aggregates of the ions or of the molecules, and compounds of ions and undissociated molecules with the solvent. It is evidently no simple matter to unravel the spectrum of so complicated a system and to determine the origin of the various bands.

The method by which the authors have attempted to do this has been to keep the number of molecules of some one particular species in the path of the beam of light constant, while varying the amounts of the other species, and then observing the effect produced upon the absorption spectrum. Unfortunately, the only molecular species about which we know enough to make it possible to apply this method are the simple ions and undissociated molecules. The authors therefore only carried out experiments, keeping, first, the total amount of salt, second, the number of undissociated molecules and, third, the number of ions in the path of the beam of light constant.

Many solutions were studied under the first-named conditions, that is, keeping the total amount of salt in the path of the light constant. Only a very few of these showed no change in their absorption spectra with changing concentration. This, of course, was to have been expected from our general knowledge of solutions, for the absorption spectra would only remain unchanged when either the relative concentrations of the different absorbers did not change with the concentration, or where the absorption spectra of all the different kinds of absorbers were identical. The first alternative is perhaps never fulfilled, but the second is very probably the explanation of the constant band of nickel sulphate solutions in the ultra-violet and of the whole constant spectra of dilute neodymium and praseodymium solutions.

Nearly as many solutions were studied under the second or third of the above conditions, that is, keeping the number of undissociated molecules or of ions in the path of the light constant. If, when the number of undissociated molecules was kept constant, the absorption *decreased* with the dilution, or if, when keeping the number of ions constant, the absorption *increased* with the dilution, we should be forced to the conclusion that the change in the absorption spectrum with the dilution could not be explained as being due simply to the differing absorption spectra of the ions and the undissociated molecules, as Ostwald at first proposed. Instead, we should be obliged to assume that other absorbers than the ions or undissociated molecules must have been present and that their formation or decomposition with the changing concentration of the solution was responsible for the observed variations. Just such variations were observed in the ultra-violet bands of copper salts and of cobalt chloride, in the red bands of cobalt salts, and in the whole spectrum of ferric chloride. It follows then that in these solutions, at least, other absorbers than simply ions and undissociated molecules must be present.

Two possibilities are suggested as to the nature of these additional absorbers. They may be either *aggregates* of the undissociated solute molecules or of the solute ions, or they may be *compounds* of the solute ions or molecules with the solvent. To decide between these two possibilities the authors cite the observations of Hartley, on the change of the absorption spectrum of salt solutions with the temperature. Hartley found that a rise in temperature in general produces the same effect as an increase in concentration. This, the authors consider, is evidence against the assumption of aggregates, for they reason that a rise in temperature would tend to break up the aggregates, while increase in concentration would have just the opposite effect, and hence produce an opposite, instead of the same effect on the absorption spectrum. It is not easy to see that this argument is conclusive, for whether or not the aggregates will break up with rising temperature will depend upon the heat change incident to their formation. If

heat is absorbed in the process, then a rise in temperature would increase rather than decrease their stability.

On the other hand, the authors reason that the assumption of compounds between solute and solvent, or the assumption of solvates, is in full accord with the observations of Hartley, for not only would rise of temperature tend to dissociate the solvates—but so would increasing concentration of solute. Here again, and for the same reason, it would seem that the argument, though reasonable, is not absolutely convincing, for it is by no means certain that a rise of temperature always accompanies the formation of solvates.

Another method of attack adopted by the authors was to study the absorption spectra of solutions of salts in ether, acetone and alcohol, and in mixtures of these solvents with water. Many salts when dissolved in these non-aqueous solvents gave different absorption spectra for different salts of the same colored ion, but the spectrum of any one salt was different in different solvents. In mixtures of water with non-aqueous solvents, many salts, like neodymium chloride, for instance, showed no marked change in the spectrum when the amount of water was varied from 100 per cent. to 15 per cent. But as the amount of water was still further reduced, the spectrum was found to consist of a superposition of the spectrum of the aqueous upon that of the non-aqueous solution. Similarly, when praseodymium chloride was dissolved in mixtures of water and of ethyl or methyl alcohol the same sort of change was in general observed, except that in the alcoholic solutions there appeared an entirely new and very brilliant band in the ultra-violet, having no analog whatever in the spectrum of the aqueous solution. The conclusion is drawn that these facts and others of a similar nature are inexplicable on any other than the solvate theory of solutions—and further, that solvates of *both* undissociated molecules and of ions are formed. In the case of cobalt and copper salts, the authors conclude that a series of solvates of varying complexity are formed, while in the solutions of the rare earth which were studied there exists but a single solvate.

Finally it was observed that neodymium nitrate and neodymium chloride have very different spectra in concentrated aqueous solutions, and that on dilution, the spectrum of the chloride changes but slightly, while that of the nitrate changes considerably and becomes identical with that of the chloride. The authors explain this phenomenon as follows. The nitrate radical, consisting of twelve atoms, is very much more complicated than the chloride radical, and hence would affect the light vibrations of the neodymium atom to a much greater extent. The effect of increasing solvation would, on the one hand, be of less relative importance to the nitrate than the chloride molecule, and, on the other hand, the effect of dissociation, that is, the separation of the nitrate radical from the neodymium atom, would produce much greater changes in its absorption spectrum than the removal of the chloride or bromide ions.

It can be seen from this cursory review how promising and yet how difficult is this line of attack. With the splendid spectrophotographs furnished by this investigation as a guide, still more valuable results might be anticipated from an accurate spectrophotometric study of the same solutions. The above qualitative tests of the various theories might then be supplemented by strictly quantitative ones.

ARTHUR B. LAMB

The Genera of Fungi. By FREDERIC EDWARD CLEMENTS, Ph.D., Professor of Botany and Head of the Department of Botany in the University of Minnesota. Pp. iv + 227, octavo. Minneapolis, The H. W. Wilson Company. 1909. $2.00.

This long-expected key to Saccardo's "Sylloge Fungorum" has now appeared from the press, as a thinnish octavo volume, bound in plain green cloth. It is not so large as to be unhandy in the using, and yet it is large enough to secure that respect from librarians and library users that its usefulness demands. In the time that has elapsed since the publication of the mimeographed edition a couple of years ago, the author has enlarged its scope, so that now a number of things are included that were not found in the original work.

Thus while the book is still essentially a key to the Fungi in Saccardo, it covers also the Fungi in Rehm's "Discomyceten" and includes the families and genera of the lichens as treated in Engler and Prantl's "Pflanzenfamilien." This treatment of the lichens is in full accord with modern botanical ideas as given in the lecture rooms of our best botanists, and yet we imagine that many a conservative botanist will be somewhat taken aback when he finds how absolutely the line between "fungi" and "lichens" has been obliterated. Thus family 18 is *Sphaeriaceae* ("fungi"); family 19, *Verrucariaceae* ("lichens"); family 20, *Hypocreaceae* ("fungi"); family 21, *Dothidiaceae* ("fungi"); family 22, *Mycoporaceae* ("lichens"), and so on; while family 36, *Caliciaceae*, includes both "fungi" and "lichens."

The "Key to Orders and Families" (pp. 1–6) gives the plan of the book, the principal succession being *Phycomycetes, Ascomycetes, Basidiomycetes* and *Fungi Imperfecti*. The boundaries of the first of these are considerably enlarged by the inclusion of the Bacteria (five families) and the Myxobacteria (one family). In the treatment of the remaining families of *Phycomycetes* they are very properly regarded as degenerated *Chlorophyceae;* so we find brief characterizations of such algal orders as *Protococcales, Spirogyrales, Vaucheriales* and *Confervales*. We imagine that some fungologists of the old school will be distinctly shocked by this close association of fungi and algae. The inclusion of *Uredinales* (*Uredinaceae* and *Ustilaginaceae*) in the *Ascomycetes*, while very acceptable to the writer of this notice, will be frowned upon by many botanists who prefer to regard them as in some way entitled to admission to the *Basidiomycetes*. These examples may serve to show that the author of the book has succeeded in putting into it some of his ideas as to relationship, which must add much to the interest as well as the usefulness of the work, especially in the hands of advanced students.

The "Guide to the Volumes of Saccardo's Sylloge Fungorum" near the end of the book will prove very helpful to every user of the many-volumed work. Likewise the alphabetical index to the families in Saccardo's Sylloge Fungorum, and Rehm's Discomyceten will be of the highest value to the mycological student. Nor must be omit reference to the glossary of Latin and English terms which will help many a student who is rusty in his Latin to "dig out" the descriptions in Saccardo.

In his preface, the author says: "No attempt has been made to revise the genera, except where the treatment had lagged behind current practise, as is particularly true of the lichens." And again: "Questions of nomenclature have necessarily been left largely to one side, but no hesitation has been felt in making certain corrections. These have dealt mostly with mistaken or neglected transliteration, and with faulty composition." Still again, "A considerable number of sesquipedalian words have been shortened and the greater number of hybrid names have been corrected."

The last quotation which we make is one that should be read by every student of the fungi—"The mycologist must have a fair equipment of technical terms, as well as a Latin vocabulary, and the sooner these are acquired the better."

The book must at once become indispensable in every botanical library, and no doubt will be in demand by every mycologist who has access to Saccardo and Rehm. Moreover, it will not take long for the student of the fungi to find that he can identify his fungi so far as genera are concerned, by means of this handy little book.

CHARLES E. BESSEY
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SCIENTIFIC JOURNALS AND ARTICLES

THE closing (October) number of Volume 10 of the *Transactions of the American Mathematical Society* contains the following papers:

C. N. Moore: "The summability of the developments in Bessel functions, with applications."

G. D. Birkhoff: "Singular points of ordinary linear differential equations."

G. A. Miller: "Automorphisms of order two."

Dunham Jackson: "Resolution into involutory substitutions of the transformations of a non-singular bilinear form into itself."

F. W. Reed: "On singular points in the approximate development of the perturbative function."

Also notes and errata for volumes 8–10, index of the volume and indices by authors and by subjects of volumes 1–10.

The November number (Volume 16, number 2) of the *Bulletin of the American Mathematical Society* contains: Report of the summer meeting of the society, by F. N. Cole; "The groups which may be generated by two operators s_1, s_2 satisfying the equation $(s_1s_2)^\alpha = (s_2s_1)^\beta$, α and β being relatively prime," by G. A. Miller; "A note on imaginary intersections," by E. W. Davis; "Maurolycus the first discoverer of the principle of mathematical induction," by G. Vacca; "Darwin's scientific papers," by E. W. Brown; "Shorter notices": Burkhardt's Elemente der Differential- und Integralrechnungen, by L. W. Dowling; Von Dantscher's Weierstrassche Theorie der irrationalen Zahlen, by G. A. Miller; Andrews's Magic squares and cubes, by G. A. Miller; d'Adhémar's Exercices et Leçons d'analyse, by Maxime Bôcher; Heger's Analytische Geometrie auf der Kugel, by L. W. Dowling; Borel-Staeckel's Elemente der Mathematik, by Florian Cajori; Love's Mathematical theory of elasticity, by F. R. Sharpe; Manville's Découvertes modernes en Physique, by E. B. Wilson; "Notes"; "New publications."

DELETERIOUS INGREDIENTS OF FOOD[1]

The Food and Drugs Act, June 30, 1906, states that an article shall be deemed to be adulterated, in the case of food, if it contain any added poisonous or other added deleterious ingredient which may render such article injurious to health. The term food includes "all articles used for food, drink, confectionery or condiment by man or animals, whether simple, mixed or compound." The act does not expressly prescribe what added substances shall be deemed to be poisonous or deleterious, nor does it indicate by what properties they are to be recognized.

At first thought this omission may seem trivial, and specific provision needless, in view of the common knowledge of these matters. More mature consideration, however, leads one to realize that there is no strict definition by which noxious and innocuous substances are differentiated; and accordingly that the recognition of poisonous and deleterious substances is not altogether a simple matter. The situation is relieved somewhat by the fact that the provision applies to added ingredients not foods and not to food itself.

Under the law, then, the question of poisonous or deleterious properties of anything coming within what the law defines as a food need not be considered. Nevertheless, in arriving at standards of the deleterious properties of added ingredients not foods themselves, it is important to consider such properties of foods, since, manifestly, it is not the intent of the law to establish different standards of quality of added ingredients than is possessed by food itself. This is clearly indicated by the statement of the law that food containing deleterious ingredients is to be deemed adulterated because the added ingredient is of such poisonous or deleterious quality as may, by its presence, render the food injurious to health. Hence, if the added ingredient is only capable of becoming deleterious in the sense that food itself is, its addition to food will not render such food injurious to health in the meaning and intent of the law. To illustrate, the addition of spices to food is admitted under the law, because they are foods in the condimental sense. Nevertheless, they are capable of being distinctly deleterious if ingested too liberally, or, in some conditions of disease, if ingested in even the ordinary quantity; that is, their proper use is without deleterious effect, yet they may become injurious by abuse. In the same way, if an added ingredient is not essentially poisonous, but merely capable of becoming deleterious by abuse, it is not a poisonous or deleterious substance in the meaning and intent of the law.

It must not be supposed that this interpretation admits of the addition to food of essen-

[1] Read before the Section of Biology, New York Academy of Sciences, May 10, 1909.

tially injurious substances in quantities not injurious, since the language of the law in the use of the word "may" specifically and very properly provides against such additions. The law reads: "If it contain any added poisonous or other added deleterious ingredient which may render such article injurious to health." It is not whether the quantity does render the food deleterious, but whether the added substance is possessed of a deleterious action which is "the nature, the property, the quality, the effect" of such added substance. If it is, the substance is essentially injurious and its addition to food is adulteration; while, on the contrary, if such added substance is only capable of becoming deleterious in the sense that food itself may, then, clearly, it is not the intent and meaning of the law to regard such added substance as essentially deleterious or its addition to food adulteration because of any such deleterious possibility.

First, then, it is important to appreciate clearly the sense in which food itself may be deleterious. Considering food that is not adulterated and is suitably prepared for ingestion, a normal individual may ingest in a normal manner a certain quantity without injurious or deleterious effect. If the quantity is increased an amount will finally be reached which is in excess of the needs of the body. However, the body is capable of adapting itself for a time to the ingestion of some excess by certain physiological adaptations, such as by the storage of caloric foods, by the rapid elimination of water or by the tonic control of reactions to stimulating foods; but when the quantity is increased beyond the capacity of such adaptations the food becomes injurious to health and a train of symptoms referable to poisonous or deleterious action is produced. This is true notwithstanding the healthfulness of the food in proper amount. This injurious effect is, then, not an essential quality of the food in question, but a quality dependent upon the ingestion of an excessive quantity of the otherwise healthful food, that is, a quality dependent upon the quantitative relation. Every food is deleterious if the quantitative relation be disregarded; it is healthful only within the limts of physiological adaptation to the quantity ingested. When these limits are exceeded it becomes injurious. Such deleterious action, however, is not an essential quality of food, since in lesser amounts, as a rule widely separated from the quantity capable of producing injury, the food does not have such deleterious action; it is a property dependent solely on the quantitative relation.

In contrast to a food let us consider the action of an admittedly poisonous substance, such, for example, as strychnine. It is poisonous because it increases the irritability of motor neurons, so that even a small quantity increases greatly the impulse resulting from a given stimulus. Such an action is not advantageous to the normal body; it is deleterious, a poisonous action. If, now, the quantity of strychnine be diminished till it no longer increases the irritability of motor neurons, no action advantageous to the healthful body remains. The poisonous action in question is one of degree, being greater with large amounts and less with small but always exhibited, so long as the quantity of strychnine is sufficient to produce any effect. It is an essential quality of the strychnine and not one dependent upon the quantitative relation. So long as the strychnine produces any effect at all it exercises the kind of action which makes it a poison. The essential quality of strychnine is, therefore, that of a poison. It is a quality exhibited in all quantities of strychnine capable of producing any definite action. To be sure, there is a range of physiological adaptation on the part of the body to an attenuated toxic effect within which no injurious action is manifest; the quality of the action persists, however, even in the diminished amount. The quality which in amount is deleterious is essential to strychnine and persists so long as the quantity of strychnine suffices to produce any definite action.

In these examples we arrive at conclusions that are of general application. An essential quality is one that is exhibited by small amounts of a substance capable of producing any definite effect. When a given quality of

action is not exhibited by a quantity of substance capable of some other different action, but is exhibited only when the quantity of the substance is a certain greatly increased amount, then the quality is not an essential quality, but one dependent on the quantitative relation.

In the application of these conclusions it is advantageous to recognize the different kinds of "added ingredients." Only those that serve some legitimate purpose in the food need be considered, as other additions would obviously be sophistication; moreover, it is convenient to classify such added substance according to the particular purpose that they serve. Thus, colors and preservatives are classes of added ingredients; they are not foods and yet may serve obvious purposes. In sufficient quantity any of these substances, like food itself, may be deleterious. Whether they are essentially injurious or whether such action is dependent on the quantitative relation is, from what precedes, to be determined according to whether they may be injurious in such quantities as are useful. If in these quantities they may be injurious or if such quantities are not widely separated from the amount that becomes injurious from the quantitative relation, then safety requires that they be considered as essentially deleterious and that they come under the designation of "added poisonous or other added deleterious ingredient." If the reverse is true, that is, if in the quantities added to food for a useful purpose the substances in question do not render such article of food injurious to health but are only capable of doing so when added in quantity widely separated from the amount made use of, then such possible deleterious action is not an essential quality of the substance, but a quality dependent on the quantitative relation, and the added ingredient is not an essentially deleterious substance and does not and may not render the article of food injurious to health according to the meaning and intent of the law. This is true whether or not the substance is capable of a deleterious action by its abuse in being used in the increased amount widely separated from the quantity which subserves the purpose of its use. In this discussion, no new position is taken in regard to these matters; there is merely an attempt to present clearly distinctions which have long been established in practical life. As an example of such practise, consider the use of cream of tartar. As a result of its use rochelle salt becomes an added ingredient to the food. When ingested in relatively large quantity this substance acts as a saline purgative, abstracting fluid from the blood and in such quantity is, in health, a deleterious substance. However, such action is not exhibited in any degree by the very much smaller quantities present because of its use in food. Hence, rochelle salt because of its laxative effect in quantity is not an added poisonous or deleterious substance according to the meaning and intent of the law, notwithstanding that it may become deleterious by its abuse. Its addition to food is justified by its usefulness and by the fact that it is not essentially injurious, even though it may become injurious in the quantitative relation.

To summarize, we conclude that substances added to food are essentially injurious when incapable of serving a useful purpose in amount widely separated from the quantity that may produce deleterious effects; and that they are not essentially injurious when capable of serving a useful purpose in amount widely separated from the quantity that may produce deleterious effect, even though, in this latter instance, they may become deleterious by abuse of the quantitative relation.

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SPECIAL ARTICLES

A NEW FORM OF LIGHT FILTER FOR USE IN EXAMINING FLAME COLORATIONS

Thin transparent sheets of celluloid stained so as to give deep absorption spectra, like solutions of methyl violet and aniline blue, absorb the orange and yellow of the spectrum. The blue screen absorbs strongly from about 23 (in the spectrum scale having D at 50) to 60, that is, including the orange-red, the orange

and half the yellow. The violet screen absorbs strongly from about 33 to 70, that is, the orange and the yellow. The sodium line at 50 is therefore absorbed by both screens. Thus in the presence of sodium the red, green and blue colors imparted to the Bunsen flame by certain elements and compounds may be readily detected by means of the screens. Certain colors transmitted by one screen are absorbed by the screens together.

The strontium and the lithium flames appear deep red through the violet screen but give no color through the blue screen. Barium and boron give a vivid green through the blue screen, and only a faint green through the violet screen. Volatile calcium salts impart a strong greenish-yellow color to the flame as seen through the blue screen, but through the violet screen the color appears a pale red. Through the combined screens the flame has a tinge of green. The color flashes out only at the moment when the salt is becoming incandescent. Potassium gives through the blue screen an intense blue-violet color; through the violet screen the outside of Bunsen flame is violet and the inside violet-red; through both screens the flame appears as through the violet screen, but less bright, and with red predominating. These colors are very characteristic. The copper chloride flame appears bright blue fringed with green through the violet screen, brilliant green through the blue screen, and a paler green through both screens. The flame color of phosphoric acid is green through the blue screen, light rose color (violet-red) through the violet screen and pale green through both screens.

In getting these flame reactions from non-volatile compounds it is, of course, necessary to use some flux or acid that will produce a volatile compound of the element sought. A silicate containing potassium may be powdered, and decomposed in a sodium carbonate bead on a platinum wire. The resulting potassium carbonate is volatile. The phosphate minerals apatite, lazulite and wavellite give the phosphoric acid reaction readily if powdered, taken up on a moistened loop of platinum wire, heated and then treated with concentrated sulphuric acid and again heated. The reaction is transient.

A screen 3×5 inches consisting of three colored strips, one blue, one violet and one blue over violet, suitable for general laboratory use, has been made for the writer by Mr. G. M. Flint, Cambridge, Mass., price 20 cents.

Such a screen is conveniently handled and is so delicate a means of identifying the elements usually sought by means of the spectroscope that its use greatly facilitates the work of laboratory instruction in qualitative analysis and mineralogy.

In case lithium light free from sodium light is wanted for use in optical mineralogy the violet screen is a very serviceable filter.

H. E. Merwin
Mineralogical Laboratory,
Harvard University,
August, 1909

THE SCOMBROID FISHES

In a recent paper "On the Anatomy and Classification of the Scombroid Fishes"[1] C. Tate Regan proposes to remove the family Carangidæ (with other families of more or less possible scombroid affinities) from its time-honored position among the scombroid fishes, and place it among the percoids.

This comes somewhat as a shock to many ichthyologists, who, while having doubts as to many of the so-called scombroids, have believed the family Carangidæ to be unquestionably a scombroid family. Mr. Regan writes of the family Carangidæ as follows:

> The more generalized members of this family (*Seriola*, *Naucrates*) have the anatomical characters of the Serranidæ, there being nothing in the structure of the cranium, vertebral column or pectoral arch to differentiate them from the latter, whilst genera like *Scombrops* and *Pomatomus* (*Temnodon*) connect the two families. In the Carangidæ the caudal peduncle is more slender, the caudal fin more widely forked, and the hypural embraced to a greater extent by the bases of the caudal finrays than in the Serranidæ, but the close relationship of the two families is evident.

[1] *Ann. and Mag. Nat. Hist.*, Ser. 8, Vol. III., January, 1909.

In the evident close relationship of the family Carangidæ to the percoid fishes the present writer wholly agrees. In working over the osteology of the scombroid fishes, he has found no character as yet by which these can be sharply and entirely separated from the percoid fishes.

This, however, is nothing new. It is well known that the carangoids merge more or less completely with the percoids, and so involve the rest of the scombroids. But it does not appear from Mr. Regan's paper why the other scombroids should not follow the family Carangidæ into the group of percoid fishes. His definition of the scombroids does not show characters to exclude the family Carangidæ. The following is his diagnosis of the suborder Scomberoidei as it stands with the carangoids left out:

Air-bladder without open duct. Maxillaries more or less attached to non-protractile premaxillaries, which are typically produced and pointed anteriorly. Cranium with the orbito-rostral portion elongate and the postorbital portion abbreviate; parietals separated by the supraoccipital; no orbitosphenoid; basisphenoid present; prootics giving rise to an osseous roof to the myodome. Vertebral column of solid centra which are coossified with the arches. Pectoral arch attached to the cranium by a forked posttemporal; no mesocoracoid; pterygials more or less regularly hourglass-shaped, 4 in number, 3 of them attached to the scapula. Pelvic fins with a spine and 5 soft rays, or variously reduced, thoracic or subthoracic in position, the pelvic bones attached to the clavicles.

These characters with a few minor exceptions are characters of the percoid fishes and spiny-rayed fishes in general, including the carangoids. These exceptions are:

Maxillaries more or less attached to non-protractile premaxillaries, which are typically produced and pointed anteriorly. Cranium with the orbito-rostral portion elongate and the postorbital portion abbreviate.

Oligoplites (family Carangidæ) has non-protractile premaxillaries, which are about as much produced and nearly as pointed as in the genus *Scomber*. Regan himself (in a footnote) finds an exception to the pointed premaxillaries in *Luvarus* (a scombroid). The character of the abbreviated postorbital portion of the cranium has many exceptions. The following are examples that are readily at hand; many more and perhaps better ones might be found. Of the family Scombridæ *Auxis, Rastrelliger* and *Scomberomorus* have the postorbital portion of the cranium scarcely abbreviate or the orbito-rostral portion elongate. Furthermore, the following carangoid and percoid fishes have these portions as much abbreviate and elongate, if not more so: *Trachurops, Gnathanodon* and *Selene* of the family Carangidæ, and *Aphareus, Orthopristis* and *Priacanthus* of different percoid families.

On the other hand, the more generalized members of the family Carangidæ have as many anatomical characters of the scombroids as of the percoids, and the well-known characters which have always appeared in connection with them (here repeated) possess enough weight to prove a closer affinity to the former than to the latter group. Scales small and cycloid; preopercle entire in the adult; caudal peduncle very slender; the caudal fin widely forked; a caudal keel and finlets sometimes present and "the hypural embraced to a greater extent by the bases of the caudal fin-rays than in the Serranidæ" (as Regan points out). Their general appearance, which should not be entirely ignored, is in favor of a closer relationship to the scombroids.

And so it appears that if the scombroids and percoids are kept apart the family Carangidæ will have to remain a member of the former group. The alternative is to consider them as one group.

The typical representatives of the scombroids and percoids are very different and they have been considered apart because they apparently form such natural groups; the scombroids centering about the family Scombridæ, and the percoids about the family Serranidæ. But the important characters that might separate them all have exceptions, and the other characters are insignificant.

Jordan and Evermann in "Fishes of North and Middle America"[2] arrange the scombroids

[2] *Bull. U. S. Nat. Mus.*, No. 47.

and percoids with the berycoids and other less important groups together under one suborder. This suborder is subdivided into "groups" so called doubtless to express a separation of convenience rather than of exactness. The following two paragraphs appear respectively under the groups Scombroidei and Percoidea.

Scombroidei.—This group of mackerel-like fishes is not capable of exact definition, its deviations from the ordinary type of spiny-rayed fishes being various and in various directions, so that no set of diagnostic characters will cover them. The group is not a suborder as the term is generally understood; it is incapable of simple definition, and in its divergence some members approach to other groups more nearly than to extreme or even to typical members of their own. The group is, however, a somewhat natural one, as by the common consent of ichthyologists its different types have always been kept near each other in the system of classification.

Percoidea.—A group of fishes of diverse habits and forms, but on the whole, representing better than any other the typical acanthopterygian fish. The group is incapable of concise definition, or, in general, of any definition at all; still, most of its members are definitely related to each other, and bear in one way or another a resemblance to the typical form, the perch, or more strictly, the sea bass of Serranidæ.

Dr. Jordan in his "Guide to the Study of Fishes" (Henry Holt & Co., New York, 1905) places the percoids and scombroids together in a suborder, excluding the other groups before associated with them, but still considering them under separate group names. This seems to be for the present the most rational treatment of the subject.

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LUMINOUS TERMITE HILLS

MANY years ago, while in the Amazon region, I found that the termite hills, which are there such a conspicuous feature in many localities, are luminous at night. My first acquaintance with this phenomenon was made in the vicinity of Santarem, Brazil, upon a nocturnal walk through the forest. In the company of some natives I was following one of the narrow paths which lead to the scattered habitations. The darkness beneath the canopy of foliage was absolute and progress was only possible by the "feel" of the ground under foot. Suddenly there appeared through the foliage a luminous area composed of innumerable points of phosphorescent light which appeared to shift and fuse into each other, thus forming more brilliant patches which were constantly resolving themselves and again appearing. This light suggested the steady diffused glow of the familiar "fox fire" rather than the more brilliant display of the fire-flies, yet the slow and confused movements which seemed to pervade the whole luminous zone were strongly suggestive of insects. Upon my expression of surprise the natives replied laconically, "cupim," the native name for termite.

The luminous area was indeed one of the large termite hills which are scattered through those parts of the forest not subject to inundation. These termite hills rise from the ground in an irregular conical mass to a height of from five or six feet to perhaps ten or twelve. They are constructed of clay and are exceedingly hard. The mounds are perfectly bare of vegetation and on that account have a characteristic appearance of newness. Afterwards I frequently saw these luminous termite hills and they added in no small degree to the mystery and charm of the tropical nights. I remember one display of particular splendor, seen when visiting at a house which commanded a view over a large clearing. Numbers of termite hills were scattered over the clearing, and at night, when these all glowed and scintillated upon the black forest background, the spectacle was one never to be forgotten.

Unfortunately I took it for granted that such a conspicuous phenomenon must be well known to naturalists and so did not investigate it. Since then I have searched the available literature on termites and on luminous insects and have questioned entomologists and botanists in the vain hope of obtaining information on this subject. The phenomenon appears to have remained unknown to naturalists. The only references to it that I

have been able to find are a brief mention in Herbert H. Smith's "Brazil, the Amazons and the Coast," p. 139 (1879), and my own allusion to it in *Entomological News,* Vol. 6, p. 15 (1895). Are the termites themselves luminous or is the phosphorescence due to some fungoid peculiar to the termite hills? Certain it is that the mounds are all phosphorescent. Smith says: "The phosphorescence is in the hills themselves, not, so far as I know, in the insects"; yet, he does not appear to have investigated this question and his statement is merely an opinion. The fact that no luminous neuropteroid insects are known argues against the theory that it is the termites themselves that emit the light, yet observations on nocturnal insects in the tropics, particularly forest insects, are so rare that such a property might easily have escaped notice. Should the light be caused by a fungus it must be one that is peculiar to the termite mounds. In the latter case, however, one would suppose that when, by the clearing of the land, the nests are exposed to the direct rays of the tropical sun the fungus would be killed; but the mounds continue luminous even in the older clearings where they have been exposed to the sun for years.

During my visit to Central America in 1905 I looked for termite nests in the hope of obtaining some data on this subject. However, I saw no termite hills like those so common in the Amazonian forests. The nests of *Eutermes,* the common form in Central America, which are built on trees and constructed of woody particles, gave entirely negative results. On one occasion I broke open one of these nests at nightfall to see if the termites within were luminous, but they showed no trace of phosphorescence.

Frederick Knab

THE PLANT REMAINS OF POMPEII

Beginning with the destruction of Krakatoa in August, 1883, within the past twenty-five years, a new era of catastrophism may be said to have begun. The events of 1902 are still fresh in the minds of most people; the destruction by earthquake on January 16 and April 18, respectively, of the towns of Chilpancingo in Mexico and Quetzaltenango in Guatemala; the eruption on May 8 of Pelée with the annihilation of St. Pierre. The partial destruction of San Francisco in April, 1906, due to a fault in the earth's surface along the Pacific coast of America, and the reawakenment of Vesuvius with the burial of Ottajano, at the foot of the volcano, are all too recent catastrophes. These manifestations of nature's force were followed by the destruction of Valparaiso in August, 1906, and Kingston, Jamaica, in January, 1907. The most recent event in which we see earth in the making, occurred at the southern end of Italy on December 28, 1908, when by an earthquake and tidal wave, the cities of Messina, Catania and Reggio were shaken from their foundations. The events of this horror are too recent to need comment, but in view of the wide-spread interest in seismic phenomena, the writer recalls a visit to Pompeii in the summer of 1907, followed later by a visit to the National Museum in the city of Naples, where the art objects and objects of commercial and domestic use are carefully preserved from the destructive action of ash storms, wind and water. A study of the ruins of Pompeii, which was destroyed by ashes, much as Ottajano was destroyed three years ago, gives one the background to picture the civilization of the ancient Pompeiians, while a study of the objects classified in the National Museum enable the student to reconstruct the daily life and industries of that pleasure-loving people. Always interested in such matters in a general way, the writer endeavored to find what materials in such a museum bore upon the study of plants. With this in view, the museum was searched and a small collection of the plant remains of the buried city was found in one corner, and the labels in modern Italian attached to the specimens were copied, making a list of twenty plants or plant parts, that could be identified certainly in the fragmentary condition in which they were preserved in the dwelling houses beneath the layers of ashes and pumice stone vomited forth by the volcano. The list

of names and their identification are given below in the hope that the list may be made permanently useful.

Agli = the garlic.
Avellani = the filbert.
Castagne = the chestnut.
Cipolli = the onion.
Coriandrum sativum = the coriander.
Fave = the bean.
Fave a meta = bean remains in fecal matter.
Fichi e uva pressa = figs and pressed grapes.
Fichi secchie a coppie = dried figs in pairs.
Fiori di melo grande = flowers of large apples.
Frammenta di pigna = fragments of pine cone, seeds included.
Garubbe = the carob.
Grano o orzo mondato = grain freed of its hull, or covering.
Hordeum hexastichum = 6-rowed barley.
Hordeum tetrastichum = 4-rowed barley.
Lenticchi = the lentil, the pulse.
Mandorle = the almond.
Miglio = the millet.
Noci = the walnut.
Pere = the pear.

We see by an inspection of this list that the residents of Pompeii used as vegetables the onion, the garlic, the bean and the lentil, while the barley (of two kinds), the millet and the chestnut were probably ground to make bread. The fresh fruits of the table were the grape, the fig, the apple and the pear. As edible nuts, the Pompeiians used filberts, chestnuts, pine seeds, walnuts and almonds, while the dried fruit comprised the fig, the carob and the grape. This is evidently only a partial list of plants actually used in Pompeii, for, as in all large cities, the vegetables and fruits sold in the markets vary with the season and the above list represents the plants on sale during late August, the date of the destruction being August 24, 79.

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NOTES ON A NEMATODE IN WHEAT

DURING the season of 1909, a nematode in wheat has made its appearance in different parts of the United States. It was found by members of the Office of Grain Investigations at Modesto, Cal., May 28, 1909, and authentic reports of its presence have since been received from Georgia, West Virginia and New York.

Affected wheat heads are similar in appearance to "bunted" heads. The glumes of the spikelets spread somewhat and galls, dark in color and full of nematode larvæ, occupy the places where the kernels should be. The nematode is undoubtedly *Tylenchus tritici* Roffr., and has been known in Europe since 1745. Its life history is described by Davaine in *Comptes Rendus Acad. Sc. Paris,* Part 41, 1855, pp. 435–438 and Part 43, 1856, pp. 148–152. The European literature on the subject is extensive, but no American citations of its occurrence in the United States are known to the writer. Sorauer in his "Handbuch der Pflanzenkrankheiten," Teil III., gives a good account of the parasite and mentions it as occurring in Sweden, Holland, Germany, Austria-Hungary, Switzerland, Italy, North America and Australia (?). Dr. E. A. Bessey in a letter of June 19, 1909, says that he has observed related forms on species of *Agropyron, Elymus, Calamagrostis, Trisetum, Chætochloa, Agrostis* and *Sporobolus* from various parts of the United States, but has not observed any form attacking wheat. The parasite has already gained headway in fields around Old Field, W. Va., and may prove a serious pest.

Infested wheat should be cleaned thoroughly before sowing. Dr. N. A. Cobb recommends cleaning by winnowing, sieving or skimming off the floating galls after the seed-grain has been submerged in water. Dr. E. A. Bessey suggests the probable efficiency of hot-water treatments such as are used for smut, and also mentions a treatment consisting of steeping seed in a two to five per cent. sulphuric-acid solution for one half to two hours. Sorauer, *l. c.*, recommends soaking infested seed in dilute sulphuric acid (1 kg. sulphuric acid to 150 l. water) for twenty-four hours. Further experiments are necessary before acid and hot-water treatments can be safely recommended.

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U. S. DEPARTMENT OF AGRICULTURE

SCIENCE

FRIDAY, OCTOBER 29, 1909

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE RELATIONS OF COLLEGES TO SECONDARY SCHOOLS IN RESPECT TO PHYSICS

THE interesting meeting of physicists which was held at Worcester from the seventh to the tenth of September, as a part of the twentieth-year celebration of Clark University, was almost unique in the amount of attention secured, from a body consisting mainly of university or college teachers, for questions relating to the best methods of teaching physics and the proper relations of school physics to college physics. The credit for this, as for the many other successful features of the meeting, was largely due to Professor Webster, who arranged for a number of conferences to consider such questions as the following, proposed by himself, and took a leading part in the resulting discussions:

1. What can be done to give the public a greater knowledge of physics?

2. What is the object of teaching physics in school and college?

3. How shall we increase the popularity of physics in the schools?

4. Shall physics be taught as if all students were to be potential physicists?

5. Shall physics be taught with more mathematics or less?

6. Is it desirable that physics and mathematics be taught by the same teachers in the schools?

7. What proportion of time must be devoted to dynamics?

8. Is a course of descriptive physics alone without mathematics or laboratory work desirable?

9. Is it desirable that the college prescribe a course in physics?

10. Can the colleges be got to prescribe a course in physics for all students?

11. What is the proper function of general physics in the curriculum of the college of liberal arts?

12. How shall physics be taught to engineering students?

13. How can the student be induced to get a more catholic view of general physics?

14. Has the introduction of courses in pedagogy been justified by the results?

15. Is there any reason that theoretical physics should languish in America?

16. Is the importation of professors of physics from Europe necessary and desirable?

No formal action was taken at any of these conferences; but at the second the nine propositions given below[1] were presented, and at the last conference a majority of those present signed the statement which follows the propositions.

1. That, while the amount of academic attainment in physics which the prospective school teacher of this subject should have can not be definitely fixed, it may be usefully, if somewhat vaguely, indicated as the state of advancement at which, if the man were to be a candidate for the doctorate, he would naturally begin the special research intended for his thesis.

2. That this preparation should include an elementary knowledge of the calculus and some acquaintance with the general facts, principles and laboratory methods of chemistry.

3. That school authorities should not be content with the appointment of a well-trained and competent teacher. They should see to it that the good teacher has good tools and good conditions for his work, a well-appointed laboratory, an equally well-appointed lecture room and relief from unnecessary manual labor.

4. That this relief of the teacher from unnecessary manual labor will require, as a rule, the services of a man of all work, sufficiently skilled to use well the elementary tools of the mechanic, sufficiently permanent in his place to know thoroughly the building in which he works and its equipment, sufficiently teachable and willing to make him a cheerful helper to the teachers of physics and chemistry in whatever assistance they may with reason ask of him.

5. That the school teacher, so trained and so equipped, should have all the liberty in the method and scope of his teaching which is consistent with the general consensus as to good practise, this consensus to be reached, in the case of schools which have close relations with the colleges, by painstaking, sympathetic and persistent efforts on the part of all concerned to come to an understanding with each other for the purpose of promoting their common interest, the best attainable instruction in science for the youth of our country.

6. That the examination by means of which the attainments of school pupils are estimated in their candidacy for admission to college should include a laboratory test.

7. That colleges which accept but do not require physics as a part of the preparation for admission should so arrange their elementary teaching of physics as to make an important distinction between those who have and those who have not passed in physics at admission.

8. That, accordingly, such colleges should maintain a physics course substantially equivalent to the physics courses of good secondary schools.

9. That colleges should require of the schools no quantitative treatment of kinetics, or the behavior of matter undergoing acceleration.

The undersigned, without committing themselves to approval of all the propositions given above, commend them to the serious consideration of college and school teachers of physics and express the hope that they may be made the subject of discussion at the coming meeting of the American Association for the Advancement of Science.

A. G. Webster (Clark University), C. L. Speyers, Norman E. Gilbert (Dartmouth College), W. E. McElfresh (Williams College), A. P. Wills (Columbia University), C. Barus (Brown University), J. C. Hubbard (Clark University), F. A. Waterman (Smith College), E. A. Harrington, Ernest C. Bryant, A. de F. Palmer, Jr. (Brown University), Norton Adams Kent (Boston University), Guy G. Becknell, Robert H. Goddard, Louis P. More (University of Cincinnati), James E. Ives (University of Cincinnati), R. W. Wood (Johns Hopkins University), E. F. Nichols (Dartmouth College), A. Wilmer Duff (Worcester Polytechnic School), C. H. Andrews (Worcester High School), C. A. Butman.

In explanation and support of these propositions[2] I gave an informal talk, the

[1] The ninth was at first in a somewhat different form from that here printed.

[2] I make these propositions entirely on my own responsibility and must not be understood to represent in this action any other member of the Harvard Department of Physics.

substance of which, with some added documentary matter, is here set down. My excuse for narrating at such length the history of college entrance requirements in physics is my belief that college men, as a rule, know very little of this history and are therefore not in position to understand fully the present condition of physics in the schools or the possibilities of improving and utilizing the work there done.

In 1886 the Harvard University catalogue contained for the first time, in its statement of the alternative requirements in physical science for admission to the freshman class, the following:

A course of experiments in the subjects of mechanics, sound, light, heat and electricity, not less than forty in number, actually performed at school by the pupil.

In 1887 a pamphlet with the title "Descriptive List of Experiments in Physics," giving detailed descriptions of apparatus and detailed directions for forty exercises to meet this requirement, was issued by Harvard.

In 1889, in response to complaints from the schools that the pamphlet just described was too restrictive, a new edition was published giving forty-six exercises, of which the candidate might omit any six.

In the year 1897–98 the Harvard catalogue contained for the first time an amended statement of the requirement in elementary physics, much longer than the original statement and with less exclusive emphasis on the laboratory work of the pupil. As this statement is still in force at Harvard, and as the influence of Harvard on the teaching of physics in schools is frequently spoken of as deplorable, it may well be given here, lengthy though it is. It reads thus:

A course of study dealing with the leading elementary facts and principles of physics, with quantitative laboratory work by the pupil.

The instruction given in this course should include qualitative lecture-room experiments, and should direct especial attention to the illustrations and applications of physical laws to be found in every-day life. The candidate will be required to pass a written examination, the main object of which will be to determine how much he has profited by such instruction. This examination may include numerical problems. It will contain more questions than any one candidate is expected to answer, in order to make allowance for a considerable diversity of instruction in different schools.

The pupil's laboratory work should give practise in the observation and explanation of physical phenomena, some familiarity with methods of measurement, and some training of the hand and the eye in the direction of precision and skill. It should also be regarded as a means of fixing in the mind of the pupil a considerable variety of facts and principles. The candidate will be required to pass a laboratory examination, the main object of which will be to determine how much he has profited by such a laboratory course.

The candidate must name as the basis for his laboratory examination at least thirty-five exercises selected from a list of about sixty described in a publication issued by the university under the title "Descriptive List of Elementary Exercises in Physics." In this list the divisions are mechanics (including hydrostatics), light, heat, sound and electricity (with magnetism). At least ten of the exercises selected must be in mechanics. Any one of the four other divisions may be omitted altogether, but each of the three remaining divisions must be represented by at least three exercises.

The candidate will be required to present a notebook in which he has recorded the steps and the results of his laboratory exercises, and this notebook must bear the endorsement of his teacher, certifying that the notes are a true record of the pupil's work. It should contain an index of the exercises which it describes. These exercises need not be the same as those upon which the candidate presents himself for the laboratory examination, but should be equivalent to the latter in amount and grade of quantitative work.

The note-book is required as proof that the candidate has formed the habit of keeping a full and intelligible record of laboratory work through an extended course of experiments, and that his work has been of such a character as to raise a presumption in favor of his preparation for the examination. But much greater weight will be

given to the laboratory examination than to the note-book in determining the candidate's attainments in physics. Experience has shown that pupils can make the original record of their observations entirely presentable, so that copying will be unnecessary, and they should in general be required to do so.

This course, if taken in the last year of the candidate's preparation, is expected to occupy in laboratory work, recitations and lectures, five of the ordinary school periods, about fifty minutes in length, per week for the whole year. With few exceptions exercises like those in the descriptive list already mentioned can be performed in a single school period, but for satisfactory results it will often be necessary to repeat an exercise. Two periods per week for the year should be sufficient for the laboratory work proper. If the course is begun much earlier than the last year of the candidate's preparation, as it well may be, it will require more time.

A new edition of the Harvard "Descriptive List" was issued in 1897. It contained sixty-one exercises, though the laboratory requirement was now reduced to thirty-five exercises.

The arrangement of exercises in the new list was peculiar, optics being interpolated between two divisions of mechanics. This was part of an attempt to encourage the performance of elementary laboratory experiments by pupils in the early years of the secondary school course or even in the grammar school.

A third edition of the list, with many changes in details but no fundamental alterations, appeared in 1903, and this, with possibly slight typographical corrections, is the current form of this familiar document.

In 1897 a committee on physics of the science department of the National Educational Association was appointed to assist in the work of the association's general committee on college entrance requirements. The make-up of the physics committee was as follows:

E. H. Hall (chairman), Harvard University.
H. S. Carhart, University of Michigan.
R. B. Fulton, University of Mississippi.
C. L. Harrington, Sachs' Collegiate Institute, New York.
Julius Hortvet, East Side High School, Minneapolis.
C. J. Ling, Manual Training School, Denver.
E. L. Nichols, Cornell University.
E. D. Peirce, Hotchkiss School, Lakeville, Conn.
Fernando Sanford, Stanford University.
B. F. Thomas, Ohio State University.
Edward R. Robbins, Lawrenceville School, Lawrenceville, N. J.

This committee evolved five general propositions which, without substantial change, were in 1890 commended by the departments of secondary and higher education of the National Educational Association and recommended to the colleges of the country "as offering a basis for the practical solution of the problems of college admission" in physics. These propositions were:

1. That in public high schools and schools preparatory for college physics be taught in a course occupying not less than one year of daily exercises, more than this amount of time to be taken for the work if it is begun earlier than the next to the last year of the school course.

2. That this course of physics include a large amount of laboratory work, mainly quantitative, done by the pupils under the careful direction of a competent instructor and recorded by the pupil in a note-book.

3. That such laboratory work, including the keeping of a note-book and the working out of results from laboratory observations, occupy approximately one half of the whole time given to physics by the pupil.

4. That the course also include instruction by text-book and lecture, with qualitative experiments by the instructor, elucidating and enforcing the laboratory work, or dealing with matters not touched upon in that work, to the end that the pupil may gain not merely empirical knowledge, but, so far as this may be practicable, a comprehensive and connected view of the most important facts and laws in elementary physics.

5. That college admission requirements be so framed that a pupil who has successfully followed out such a course of physics as that here described may offer it toward satisfying such requirements.

But the general committee on college entrance requirements insisted on having more detailed recommendations from the physics committee. Accordingly I, knowing that various members of this latter body, if body it could properly be called with its parts separated by hundreds or even thousands of miles, held strongly to various opinions concerning details, at last sent to the general committee as my personal suggestion the titles of the Harvard "Descriptive List," at the same time notifying every other member of the physics committee of my action and asking each to make any suggestion of his own in the same way. To my surprise only one other member of the committee sent any recommendations of his own. Professor Carhart sent a number, which, however, were probably not intended as a complete alternative for the Harvard list. The general committee printed both sets of suggestions, with some introductory paragraphs of which one only need be given here:

OUTLINE OF LABORATORY WORK IN PHYSICS FOR SECONDARY SCHOOLS

At least thirty-five exercises, selected from a list of sixty or more, not very different from the list given below. In this list the divisions are mechanics (including hydrostatics), light, heat, sound, and electricity (with magnetism). At least ten of the exercises selected should be in mechanics. The exercises in sound may be omitted altogether; but each of the three remaining divisions should be represented by at least three exercises.

This paragraph, too, with the list which followed, became a part of the matter recommended to the colleges of the country in 1900 by the departments of secondary and higher education of the National Educational Association.

In 1901 the "Definition of Requirements," issued by the recently established College Entrance Examination Board of the Middle States and Maryland, contained the following statement:

The requirement in physics is based on the report of the committee on physics of the science department of the National Educational Association.

It is recommended that the candidate's preparation in physics should include:

(*a*) Individual laboratory work, comprising at least thirty-five exercises selected from a list of sixty or more, not very different from the list given below.

(*b*) Instruction by lecture-table demonstrations, to be used mainly as a basis for questioning upon the general principles involved in the pupil's laboratory investigations.

(*c*) The study of at least one standard textbook, supplemented by the use of many and varied numerical problems, "to the end that the pupil may gain a comprehensive and connected view of the most important facts and laws in elementary physics."

The list of titles of experiments which follows this passage in the original context is precisely the same as that numbered from 1 to 61 in the report of the National Educational Association and in the Harvard "Descriptive List."

All this may seem to be a record of easy and triumphant progress, during the years 1897–1901, for the physics course under discussion. Perhaps the ease was too great for the triumph, if such there was, to last. Criticisms and complaints soon began to be heard. At a meeting of the New England Association of Colleges and Preparatory Schools in October, 1901, President Hall, of Clark University, pronounced a sweeping condemnation of the kind of physics teaching which had come into the schools through the influence especially of Harvard College. This was the more significant, rather than less, by reason of the fact that President Hall had during the early years of the Harvard "Descriptive List" expressed approval of its character. In spite of an early prepossession in its favor, he had become entirely dissatisfied by its working in the schools, as he understood the results of that working. Nor did he long remain alone as a pronounced critic

and opponent of the system of physics teaching under discussion. Professor Woodhull, of Teachers College, Columbia University, as the spokesman, no doubt, of a considerable proportion of the physics teachers in middle state schools, took a similar position. More conspicuously still, Professor Mann, of the University of Chicago, proclaiming in no uncertain tones the need of a "new movement among physics teachers," undertook to organize against the prevalent system the discontent of physics teachers throughout the country and to formulate proposals for a change. Many committees were accordingly appointed, many *questionnaire* circulars were issued, much cogitation of replies was gone through—with what result may appear later in this history.

Indeed, so active has been the fire of criticism and of condemnation directed during the last six or eight years against the influence of colleges on the school teaching of physics that, in representing the large share held by Harvard in this influence, I am making something in the nature of a confession. Nevertheless, there are several reasons for believing that the influence in question has not been altogether bad and that the present condition of physics in the schools does not need to be reformed altogether. Some of these reasons I will give.

1. The college requirement of laboratory work by school pupils has done much to make the school teaching of physics in this country a respected profession instead of a mere incidental occupation, as it used to be, for some teacher whose main work lay in another field. There are now in this country several large and vigorous associations of physics teachers. To one of the largest and best of these, the Eastern Association of Physics Teachers, I have the honor of belonging, as an associate member. I attend its meetings regularly and believe I am right in saying that, on the whole, it is fairly well satisfied with the college requirement in physics as maintained and administered by Harvard. That is, where the Harvard plan has been longest on trial and has had the most direct and powerful influence, it is better liked than in other parts of the country.

2. European countries are gradually establishing in their secondary schools courses of laboratory work closely resembling those given in the schools of this country, and complimentary references to American practise in this respect are frequent in the writings of European teachers, some of whom freely declare their indebtedness to American precedents.

3. The "new movement among physics teachers," mentioned above, has had remarkably little revolutionary effect, less, indeed, than I think it should have. To justify this statement I will give a brief account of the recent movement for the revision of the physics requirement of the College Entrance Examination Board.

Early in 1908 a committee was appointed to make this revision. Its membership was: Henry S. Carhart, University of Michigan; A. D. Cole, Vassar College; A. W. Goodspeed, University of Pennsylvania; John W. Hutchins, High School, Walden, Mass.; Flavel S. Luther, Trinity College, Hartford; C. R. Mann, University of Chicago; C. A. Perkins, University of Tennessee; Frank Rollins, Stuyvesant High School, New York City; Wallace C. Sabine, Harvard University (chairman); H. L. Terry, inspector of schools, Madison, Wis.

Late in the year this committee made a majority report to the general board of revision of the College Entrance Board, and two members, Professor Mann and Mr. Terry, made a minority report. The following quotations from the minority re-

port will show what impression the majority report made on those who had been active in the "new movement" and will be a fitting introduction to the next stage in this history:

We dissent from the report of the majority for the following reasons:

The underlying principle of the report of the majority is that physics is essentially a science of accurate measurements—the only such subject in the high school course—and hence it is the duty of physics to lay great stress on accurate quantitative work in order that the high school pupils may get somewhere in this course an insight into such work.

. . . .

Your minority is convinced that physics as a science of exact measurements belongs wholly in the college, and that physics in the high school should not give such prominence to the science of accurate measurements nor make use of the abstract and unusual system of absolute units. We respectfully urge that high school physics should teach the student how to organize his experience with physical phenomena in such a way as to get clear conceptions of some of the larger laws of physical nature. In this process experiments and to some extent quantitative work are necessary; but such highly refined quantitative work as is now generally demanded should not be insisted on, and all such work should be done in terms of the familiar engineers' units like the pound-weight and the foot-pound instead of the dyne and the erg.

Your minority wishes also to point out that your committee on this physics requirement is not a representative committee.

. . . .

We therefore are convinced that the report of the majority does not represent the consensus of opinion of the ablest secondary school teachers as to the present needs of physics in the high school; but that it is simply a statement of the current habits of teaching physics—habits that have been developed under the influence of ideals of college physicists rather than because of an appreciation of the ideals of the high school pupils.

. . . .

In view of this, your minority wishes to make the following recommendations to your board:

1. That the board of review increase the size of its physics committee by appointing or getting appointed in such a way as it may elect six or more physics teachers from various sections of the country who are recognized as successful and experienced teachers of physics and who are at present actively engaged in teaching physics in secondary schools. This would insure a representative committee.

2. That the report of the majority and the minority, together with similar reports of the North Central Association of Colleges and Secondary Schools and of the Physics Club of New York, be referred back to this more representative committee for full and complete discussion.

The board of revision, instead of following strictly the first recommendation made by the minority of the original committee, appointed a new committee consisting solely of six physics teachers in secondary schools, and to this committee it turned over the whole, I believe, of the matter mentioned in the second recommendation, as given above. The membership of the new committee was: N. Henry Black, Roxbury Latin School, Boston (chairman); W. M. Butler, Yeatman High School, St. Louis; Winthrop E. Fiske, Phillips Academy, Exeter, N. H.; Daniel E. Owen, Penn Charter School, Philadelphia; Frank B. Spaulding, Boys' High School, Brooklyn; Willis E. Tower, Englewood High School, Chicago.

In April, 1909, this committee made its report to the College Entrance Board. This report was in part as follows:

In submitting this report, we desire to call attention to the following points:

1. The report has received the unanimous approval of the committee.

2. We recommend that the College Entrance Board no longer undertake the marking or examination of the laboratory note-book[3] (see form of certificate recommended in lieu thereof).

3. We urge upon those who prepare the examination questions that these be so planned that students who have received fair preparation on

[3] I am informed by the chairman of the committee that this recommendation was due to the difficulties experienced by the College Board in receiving and transmitting the great number of note-books it has hitherto undertaken to deal with.

this work as here outlined may reasonably be expected to pass.

GENERAL STATEMENT

1. The unit in physics consists of at least 120 hours of 60 minutes each. Time spent in the laboratory shall be counted at one half its face value.

2. The course of instruction in physics should include:

(a) The study of one standard text-book, for the purpose of obtaining a connected and comprehensive view of the subject. The student should be given opportunity and encouragement to consult other scientific literature.

(b) Instruction by lecture-table demonstration to be used mainly for illustration of the facts and phenomena of physics in their qualitative aspects and in their practical applications.

(c) Individual laboratory work consisting of experiments requiring at least the time of thirty double periods. The experiments performed by each student should number at least thirty. Those named in the appended list are suggested as suitable. The work should be so distributed as to give a wide range of observation and practise.

The aim of the laboratory work should be to supplement the pupil's fund of concrete knowledge and to cultivate his power of accurate observation and clearness of thought and expression. The exercises should be chosen with a view to furnishing forceful illustrations of fundamental principles and their practical applications. They should be such as to yield results capable of ready interpretation, obviously in conformity with theory, and free from the disguise of unintelligible units.

Slovenly work should not be tolerated, but the effort for precision should not lead to the use of apparatus or processes so complicated as to obscure the principle involved.

3. Throughout the whole course special attention should be paid to the common illustrations of physical laws and to their industrial applications.

4. In the solution of numerical problems, the student should be encouraged to make use of the simple principles of algebra and geometry, to reduce the difficulties of solution. Unnecessary mathematical difficulties should be avoided and care should be exercised to prevent the student's losing sight of the concrete facts, in the manipulation of symbols.

The "appended list" of laboratory exercises which "are suggested as suitable" contains fifty-one titles, mostly one-line titles, without any details of method. The great majority of these are practically equivalent to titles found in the list, with sixty-one titles, originally adopted by the College Entrance Board or to combinations[4] of such titles. The new titles to which, apparently, nothing in the original list explicitly corresponds are the following:

15. Efficiency test of some elementary machine, either pulley, inclined plane or wheel and axle.

16. Laws of the pendulum.

17. Laws of accelerated motion (if by this is meant a laboratory study by the pupils of falling bodies and not the comparison of masses by acceleration-test and the action and reaction, of the old list).

23. Cooling curve through change of state (during solidification).

38. Magnifying power of a lens (if this means more than is implied in the shape and size of a real image formed by a lens, of the old list).

39. Construction of model of telescope or compound microscope.

41. Magnetic induction (unless this is covered by the telegraph sounder and key, the electric motor and the dynamo, of the old list).

45. Electrolysis (which apparently means something additional to the study of a single fluid voltaic cell and study of a two fluid voltaic cell, titles taken from the old list to the new).

47. Resistance measured by volt-ammeter method.

50. Study of induced currents (if this means more than the dynamo, of the old list).

51. Power or efficiency of a small electric motor (if this means more than the electric motor of the old list).

The report in question gave also a syllabus of "topics which are deemed fundamental and which should therefore be included in every well-planned course of elementary physics." As this syllabus covers nearly four type-written pages and seems to include nearly everything that one would expect to find in the table of contents of a

[4] For example, where the original list had *elasticity: stretching; elasticity: bending; elasticity: twisting*, this new list has *Hook's law*.

general school text-book of physics, I shall not reproduce it here.

This report, made unanimously by a committee of six school teachers of physics, was accepted *in toto* by the College Entrance Board and now stands as the extended definition of the physics requirement of that board. I here repeat the opinion which I have expressed earlier in this paper, that the revision, left at last entirely to experienced school teachers of physics, has made no revolutionary change in the requirement, and that we are therefore justified in concluding that such teachers do not condemn as bad, on the whole, the influence of college requirements on the school teaching of physics.

It would be quite a different thing, however, to express for myself or for school teachers the opinion that the present state of physics in the schools is satisfactory, except as a temporary stage of development under difficult conditions. Many teachers, especially those new to the kind of work required, have too little knowledge of their subject, many school boards are unwilling or unable to give the teacher proper facilities and needed assistance, many college men are out of sympathy with school men and take too little account of what they accomplish. Finally, we have thus far attempted, in my opinion, to cover too wide a field in school courses, or, at least, we have attempted one part of this field which is impracticable with an ordinary class in a school course, the region of dynamics, or kinetics. Seven or eight years ago I raised the question, "Should we, therefore, give up the attempt to teach this part of physics in school courses, or the early courses in college and content ourselves with giving, in mechanics, the statical aspect only?" and said, "I fear that many teachers will answer this question in the affirmative, but I am not yet ready to do so." Now, after years of further experience and observation, I have come to the point of making proposition 9 in the early part of this paper. I have been brought to this point partly by what I have heard in the debates of the Eastern Association of Physics Teachers, partly by the opinions expressed by other associations of teachers with the encouragement of Professor Mann and Professor Woodhull, but largely by my own experience and observation of pupils. Here, it seems to me, rather than in its assault on the general character of college requirements in physics, the "new movement" has found a vulnerable place and has indicated a way of improvement.

When the physicist looks at the familiar formula,

$$\text{force} = \text{mass} \times \text{acceleration},$$

notes its simplicity and lets his mind enter for a moment the vast regions of illumination and power which it opens up, he is only too apt to overlook the aspect which this law takes for the beginner in physics in this country. Let me, therefore, write down several of the forms in which the youngster is asked to recognize and use it:

$$\text{force (dynes)} = \text{mass (grams)} \times \text{accel. (cm. per sec. per sec.)},$$
$$\text{force (poundals)} = \text{mass (pounds)} \times \text{accel. (ft. per sec. per sec.)},$$
$$\text{force (gms.-wt.)} = \text{mass (grams)} \times \text{accel. (cm. per sec. per sec.)} \div g (= 981),$$
$$\text{force (lbs.-wt.)} = \text{mass (pounds)} \times \text{accel. (ft. per sec. per sec.)} \div g (= 32 +).$$

Even without adding to these the form which many engineers would insist on, *force (lbs.-wt.) = mass × acceleration,* in which the mass of a one-pound weight is called $(1 \div g)$, we see that the difficulty is a serious one. Are we justified in putting it in the way of school pupils who, in the great majority of cases, will never have occasion, after their academic days, to use the acceleration formula in any shape, and who will find in the other regions of physics

plenty of interesting and useful matter to occupy their attention during that small part of their school course which can be devoted to this subject? And would not college teachers of physics prefer to have boys come to them from the schools well grounded in the elements of static mechanics, without kinetics, than to have them come with a very uncertain knowledge of both?

EDWIN H. HALL

CAMBRIDGE, MASS.,
September 23, 1909

THE INTERNATIONAL CONGRESS OF RADIOLOGY AND ELECTRICITY

AN international Congress of Radiology and Electricity is to be held in Brussels from September 13 to 15, 1910, under the patronage of the Belgian government and the French Physical Society. This is the second conference on the subject, the first having been held in Liège, in the autumn of 1905. The second conference, like the first, has on the honorary committee some of the leading scientists in Europe and America who are working along the lines included in the subjects of the conference. The list includes among others Madame Curie, Lord Rayleigh, Sir W. Ramsay, Sir J. J. Thomson, Sir O. Lodge, Sir Wm. Crookes, Professors Lorentz, Rutherford Langevin, Arrhenius, Lenard, Goldstein, H. Poincaré, Planck, Righi, Schuster, Zeeman and certain eminent physicians.

The congress has for its chief purpose the bringing together of a number of scientists capable of discussing the fundamental problems arising out of the phenomena of radioactivity and ionization; of agreeing upon a standard terminology; of presenting reports embodying a summary of our knowledge on the various divisions of the subject; and of showing the medical and therapeutic applications of the phenomena. The conference is therefore of concern to physicists, chemists, biologists and medical practitioners.

The officers of the American committee are at present Professor Carl Barus, Brown University, Providence, R. I., chairman, and Professor G. F. Hull, Dartmouth College, Hanover, N. H., secretary, to whom inquiries may be addressed.

The provisional program of the conference is as follows:

FIRST SECTION—TERMINOLOGY AND RADIOMETRY

Terminology.—Fundamental notions; ions, electrons, corpuscles, etc. Unification of notations.

Radiometry.—General methods of measurement; apparatus, units.

Measurement of radioactivity; supports of the radioactive body; its influences, standardization. The establishment of a unit of radiation. Applied radiometry.

SECOND SECTION—PHYSICAL SCIENCES

A. *Theories and Fundamental Hypotheses*.—The ether, its manifestations, its properties, its relations to matter. The electric and magnetic field, electrons and ions; formation and properties. Magnetic and electric properties of bodies; metallic conductivity, electrolysis; dielectric phenomena; magnetism. Contact electricity. Thermoelectricity. Electro-capillary phenomena.

B. *Radiation*.—Generation. Emission, absorption; phenomena of radiation. Observation and analysis of radiation. Spectroscopy. Physical and chemical effects of radiation, phosphorescence. Electro-optics and magneto-optics, the Zeeman effect. Applied radiology, apparatus.

C. *Radioactivity*.—Radioactive bodies; enumeration and distinctive characters of the methods of separation. Radioactivity of matter in general. Properties of radioactive substances. Radioactive transformation; emanation, induced activity, etc. Atomic disaggregation. Radioactive constants.

D. *Atomistics*.—Number, charge, mass and velocity of particles. Molecular and atomic structure; valency. Colloids; Brownian movements.

E. *Cosmical Phenomena*.—The atmospheric electric field; its origin, variations of electrical potential of the atmosphere; ionization of the atmosphere. Observatories for atmospheric electricity; organization. Systematic registry of atmospheric electricity. Atmospheric radioactivity; atmospheric precipitation. Distribution of radioactive substances on the surface and in the interior of the earth. Terrestrial magnetism. The aurora borealis and magnetic storms. Solar radiation; variability of the field of this radiation, its heterogeneity and influence on terrestrial phenomena. Solar magnetic fields.

THIRD SECTION—BIOLOGICAL SCIENCES

A. *Biology Proper*.—Under this schedule are to be included all communications relative to the

action of different radiations on organisms. The following topics have thus far been proposed as being suitable for special reports: (1) Action of the X-rays and of radioactivity on cellular structure; (2) action of radiations in general on the development of plants.

B. *Medical Radiology.*—Radio-diagnosis. This schedule is to include all the medical applications of radioscopy and radiography. Three topics have been admitted up to the present time as probably suitable for reports: (1) Rapid radiography; instantaneous radiography; (2) study of the stomach and of the intestines, from the physiologic and the pathologic points of view; (3) endodiascopy.

C. *Radio-therapeutics.*—Under this schedule will be included all reports appertaining to the treatment of diseases by radiation. (*a*) X-rays; (*b*) radioactivity; (*c*) other radiations. The following topics have also been provisionally considered: (1) The filtration of rays (X-rays and radioactivity); (2) radioactive medicines; (3) treatment of tumors by radium; (4) present state of photo-therapeutics and its different methods.

The specifications of the present program are merely provisional; they are to be considerably altered in the final revision. A special exposition of all apparatus and appliances comprehended under the present subject will be annexed to the congress.

Attention may finally be directed to certain rules of the congress.

Art. 2.—The following persons will be members of the congress and they alone will receive the publications: (1) the delegates of the Belgian public administration and the delegates of foreign governments; (2) donors, including those persons who have given a sum of 100 francs or more; (3) all persons who have contributed the sum of 20 francs. The wives of members as well as their unmarried children may be registered as associates at a fee of 10 francs. The same charge will be made to students.

Art. 3.—The members of the congress and their associates will alone have the right to participate in its scientific transactions, to take part in its excursions, etc.

All members will receive the publications in full, both before and after the session of the congress. They will be entitled to enter the exposition at Brussels gratuitously on presenting their cards.

It is particularly requested that all communications of a financial nature (membership fees, etc.) be addressed directly to the general secretary of the committee on organization, M. Daniel, No. 1 Rue de la Prévôté, Brussels, Belgium.

By order of the American Committee.

Hanover, N. H.

G. F. Hull,
Secretary

WINTER MEETING OF THE AMERICAN CHEMICAL SOCIETY

The winter meeting of the society will be held in Boston, Mass., December 28 to 31 inclusive, in affiliation with the American Association for the Advancement of Science, whose associated societies meet throughout the week.

Railroad rates will probably be secured as usual and as there is to be a large gathering of scientists in Boston this winter, there will undoubtedly be a sufficient number of persons present to make these reduced rates available.

The society will meet in six divisions and two sections under the guidance of the officers enumerated below.

Divisions

Agricultural and Food Chemistry.—Chairman W. D. Bigelow, Bureau of Chemistry, Washington, D. C.; secretary, W. B. D. Penniman, 213 Courtland St., Baltimore, Md.

Fertilizer Chemistry.—Chairman, F. B. Carpenter, Richmond, Va.; secretary, J. E. Breckenridge, Carteret, N. J.

Industrial Chemists and Chemical Engineers.—Chairman, A. D. Little, 93 Broad St., Boston, Mass.; secretary, B. T. Babbitt Hyde, 82 Washington St., New York City.

Organic Chemistry.—Chairman, R. S. Curtiss, University of Illinois, Urbana, Ill.; secretary, Ralph H. McKee, Orono, Maine.

Pharmaceutical Chemistry.—Chairman, A. B. Stevens, University of Michigan, Ann Arbor, Mich.; secretary, B. L. Murray, Merck & Co., New York City.

Physical and Inorganic Chemistry.—Chairman, C. H. Herty, Chapel Hill, N. C.; secretary, W. D. Bancroft, 7 East Ave., Ithaca, N. Y.

Sections

Biological Chemistry.—Chairman, S. C. Pres-

cott, Massachusetts Institute of Technology, Boston, Mass.

Chemical Education.—Chairman, H. P. Talbot, Massachusetts Institute of Technology, Boston, Mass.

A sectional meeting for the special consideration of rubber chemistry is also proposed and any one interested is requested to write the secretary at once.

Members desiring to present papers are requested to send title and brief abstract to one of the above named persons, except for the Section of Chemical Education, where a special program is being arranged, on or before November 15 or to the secretary of the society on or before November 19. Titles of all papers *received* before November 20 will appear on the preliminary program, which will be sent to all members. The final program will be sent only to those members signifying their intention of being present at the meeting or who make special request for same. No title can be placed on the final program that reaches me later than December 10. In the preparation of papers for presentation a clear and concise statement of results obtained and conclusions reached should alone be given. All unessential and technical details should be reserved for the published paper, as the time that can be allotted is limited and papers given in this manner are always much better received. Any person requiring more than fifteen minutes for the delivery of his paper should either abstract it sufficiently to come within this time or obtain a special extension by writing to the chairman of the division previous to the meeting.

Summer Meeting, 1910

The summer meeting of 1910 will be held in San Francisco at a date not yet decided upon. Special notice of this meeting is inserted here in order that members may be planning some time ahead for this trip to California. The California Section is making special arrangements for our entertainment and attempts will be made to have a special train or at least special cars leaving from some central point for eastern members so that they may go together and obtain additional enjoyment from the journey. It is possible that side trips may be arranged and it is expected that the date will precede the date of the meeting of the American Association for the Advancement of Science in Honolulu so that members who desire may go to this meeting after the meeting of the American Chemical Society. The secretary hopes that all members who intend to attend this meeting will write him so that a general idea may be obtained as to the possibility of special arrangements.

American Chemical Society, 1909

The current year has been one of continued growth and success for our society as shown by an unusual enthusiasm among its members and by the large increase in membership. The society is now the largest chemical society in the world and approximates 4,500 members.

The publications of the society have for two years been issued on time and they have acquired a standing which should be a source of pride to every member. *Chemical Abstracts* continues to be received with acclaim the world over and its influence for the good of the society is continually growing. The new *Journal of Industrial and Engineering Chemistry*, with its board of thirty-five editors, all of whom are specialists in the lines they represent, has now nearly completed its first year with results that speak for themselves. It is also worthy of note that the new paper used in the *Journal of the American Chemical Society* and in *Chemical Abstracts*, which was adopted on the recommendation of the highest expert advice in America, is adding greatly to the usefulness of these two publications. On account of its lightness, strength and durability, *Chemical Abstracts* can this year be bound in two volumes instead of in three as heretofore, and the *Journal of the American Chemical Society*, which had already reached such a size that further binding in a single volume was out of the question, can now be bound as heretofore, making it much more attractive for our library shelves. The resultant saving in binding cost of two large volumes will be appreciated by the membership.

During the year President Whitney has visited a large number of the local sections of the society and increased their enthusiasm by the spirit he has shown.

The Baltimore meeting was the largest ever held in the history of the society and the Detroit summer meeting, while smaller in numbers than the winter meeting, which is always the case, had the largest attendance of any meeting ever held by the society in the summer. Both meetings were thoroughly enjoyed by the members present.

The policy of organizing the society in divisions, begun in 1908, has been continued during the present year and the Divisions of Physical and Inorganic Chemistry, Fertilizer Chemistry, Agricultural and Food Chemistry, Organic Chemistry and Pharmaceutical Chemistry have been established and their work is daily growing in importance. Members who have not identified themselves with those divisions in which they are especially interested should do so at once by dropping a postal card to the secretary of the division.

It is hoped that all members will make a special effort to be present at the Boston meeting. Too few of our members realize the inestimable benefit to the individual and the profession which may be gained by regular attendance at the general meetings of the society. A member who is not thoroughly acquainted may feel a little strange at the first meeting which he attends, but he is sure to make many friends and get much information, and if he attends two meetings in succession begins to feel so thoroughly at home that he is almost always seen thereafter. Those who have once realized the great advantage of being present seldom fail to attend if possible.

Local sections have been established during the year at Milwaukee, Wis.; Cleveland, Ohio; Seattle, Wash., and Columbia, Mo. The local sections have, with one or two possible exceptions, fully met the spirit which pervades the whole society of due economy in their local expenses in order that the funds of the society may be utilized to meet the great cost of our publications, for most of the members realize fully that the society is expending a much larger proportion of its income upon its publications than any other unendowed society in the world. Every member secures the benefit of any sacrifice he may make in his local section by the increased good which results to the whole society therefrom. Some of the sections have again this year entirely met their own expenses while others have been run at a minimum cost.

Members will be interested to know that our official delegate to the World's Congress of Chemists in London, Dr. W. H. Nichols, was elected acting president of the World's Congress of Chemists to be held in the United States in 1912 and that our honorary member, Dr. E. W. Morley, was elected honorary president.

Official Insignia or Pin

Members will be interested to note that an official insignia or pin for the society was adopted at the Detroit meeting. This badge may be obtained from Tiffany & Company, of New York, in the form of a pin, button or scarf pin, on order obtained by addressing the secretary of the society. The pin is of fourteen-carat gold and is one of the most attractive emblems possessed by any of the scientific societies of the country. It consists of a square with one of the points forming the top of the pin. The upper triangular half of the square contains the figure of a phœnix rising from the flames, typical of chemical activity and of the new birth of substance through the energy of chemical change. The lower part of the square contains in gold the letters *A. C. S.* and a small, unobtrusive Liebig bulb on a background of enamel.

Future of the American Chemical Society

The future success of the society and the returns it can make to its members will, as heretofore, depend largely upon the size of that membership, as additional funds are required to continue and enlarge the work we have undertaken. It may seem to some that now we are the largest chemical society in the world the effort for a continued increase in membership is not warranted as it has been, but there are still some three thousand chemists and possibly more in the country who have

not joined in the work we are undertaking who ought to be with us, for our efforts are for the benefit of every chemist in America and every chemist should do his part. The only way to reach these is through the energetic, individual help of the members, who can aid the society in this way.

Some of these non-members probably never can be made to understand that they have any part to perform in elevating the standard of the profession in the country nor see any personal responsibility therein so long as they are able to read journals provided for them by others. Possibly a few have no ambition for personal advancement and care little about the advancement of American chemistry as such, but this is not true of many. Some have not been invited, but with most the reason that they are not with us is simply due to the fact that the matter has not been presented to them individually in the correct light. The argument of the journals we are publishing, of the fact that more and more corporations are urging their chemists to identify themselves with us, that many employers are asking whether or not young men belong to our society as a guarantee of the fact that they are alive and interested in the development of the profession, has been placed before them, but the fact that they are not personally assisting in the movement and that it is their duty as well as privilege to do so may not have been shown. These non-members do not realize that if we had no more than one thousand members our present publications would cost those members at least thirty dollars per year each; that by the union of 4,500 chemists we have been able to return to the individual material which could not have been furnished in any other way and that two thousand more members will enable us almost to double the work that we are now doing. Will you not help present to them the fact that it is this *union* of American chemists that is so rapidly advancing American chemistry, that is giving it prominence approaching nearer and nearer to that of Germany and that they should, if worthy members of that profession, do their annual part towards its development.

Census of American Chemists

The secretary is attempting to secure a list of all American chemists with their addresses, whether they are members of the American Chemical Society or not. He would be greatly obliged to any member who will send him names and addresses of non-members of the society in order that they may be added to this list if not already thereon. It would be a special favor if chief chemists of large industrial firms would send him a list of all chemists in their employ to be checked off for this purpose.

Charles L. Parsons,
Secretary of the American Chemical Society

THE NATIONAL CONFERENCE COMMITTEE ON STANDARDS OF COLLEGES AND SECONDARY SCHOOLS

The fourth annual meeting of the National Conference Committee on Standards of Colleges and Secondary Schools was held in the rooms of the dean of the Graduate School of Arts and Sciences of Harvard University, University Hall, Cambridge, Mass., on Saturday, October 9, 1909. All the organizations which send delegates to the conferences of this committee were represented, the delegates being as follows: President George E. MacLean, the State University of Iowa, from the National Association of State Universities; Headmaster Wilson Farrand, Newark Academy, from the College Entrance Examination Board; Professor Nathaniel F. Davis, Brown University, from the New England College Entrance Certificate Board; Dean Herman V. Ames, the University of Pennsylvania, from the Association of Colleges and Preparatory Schools of the Middle States and Maryland; Principal Frederick L. Bliss, the University School of Detroit, from the North Central Association of Colleges and Secondary Schools; Chancellor James H. Kirkland, Vanderbilt University, from the Association of Colleges and Preparatory Schools of the Southern States; Secretary James G. Bowman (in place of President Henry S. Pritchett), from the Carnegie Foundation for the Advancement of Teaching; Dr. Elmer E.

Brown, the United States Commissioner of Education, and Dean Frederick C. Ferry, Williams College, from the New England Association of Colleges and Preparatory Schools.

The officers of the past year were reelected as follows:

President—President George E. MacLean.

Vice-President—Headmaster Wilson Farrand.

Secretary-Treasurer—Dean Frederick C. Ferry.

The sub-committee of four, consisting of Headmaster Farrand, President Pritchett, Principal Bliss and Dean Ferry, appointed at the 1908 meeting to formulate the definition of the minute for the measurement of admission requirements, submitted a final report on this question, which was adopted after slight modification in the following form:

(DEFINITION)

A unit represents a year's study in any subject in a secondary school, constituting approximately a quarter of a full year's work.

(EXPLANATION)

This statement is designed to afford a standard of measurement for the work done in secondary schools. It takes the four-year high-school course as a basis, and assumes that the length of the school year is from thirty-six to forty weeks, that a period is from forty to sixty minutes in length, and that the study is pursued for four or five periods a week; but, under ordinary circumstances, a satisfactory year's work in any subject can not be accomplished in less than one hundred and twenty sixty-minute hours or equivalent. Schools organized on any other than a four-year basis can, nevertheless, estimate their work in terms of this unit.

The sub-committee was requested to continue its consideration of various subjects already before it and to report again at the next meeting. It is hoped in particular that it will present at that time recommendations as to some accurate use of the terms "progress of study," "curriculum," "course of study," "hour," "count," "point," "exercise," etc.

The committee passed a resolution expressing its approval of the tendency shown by many colleges to make their definitions of admission requirements conform to those of the College Entrance Examination Board, and its hope that the definitions of admission requirements published by that board come into universal use.

It was voted to invite the Association of American Universities to accept membership in the committee and to send a delegate to its meetings.

The full minutes of the proceedings of the conference will be printed and distributed to the members of the associations which are represented in the committee.

Frederick C. Ferry,
Secretary-Treasurer

THE NEW ENGLAND GEOLOGICAL EXCURSION

The ninth annual intercollegiate geological excursion of New England was held in the northern Berkshires, Massachusetts, on Saturday, October 9, 1909, under the leadership of Professor H. F. Cleland, of Williams College. Representatives from Bates, Brown, Dartmouth, Harvard, Mt. Holyoke, Smith, Tufts, Wellesley, Wesleyan, Williams and Yale Colleges, the normal schools at Boston, North Adams, Salem and Worcester and other institutions, a total of 44, gathered for a preliminary discussion in Hotel Wendell, Pittsfield, on Friday evening. At this meeting papers were read on the glacial geology of the region to be traversed by Professor Cleland, on the areal geology by Professors Barrell and T. Nelson Dale, and on the anthropogeography by Professor Davis.

The party left Pittsfield at eight o'clock, Saturday morning, on a special electric car and made its first stop at the outlet of Glacial Lake Bascom. Here Professor Cleland explained the conditions attending the formation and the various halts of this former lake, and Professor Davis discussed the esker which traversed the valley. A second stop was made at the glass sand quarries and mill at Cheshire where Professor Emerson spoke of the origin of the sand and furnished the party with an explanation of its physical characters. Mr. C. Q. Richmond, superintendent of the Berkshire Street Railway, gave an interesting description of the industries of the Hoosic valley.

Following this, a fine series of glacial forms were seen; a kame terrace, which was the subject of a talk by Professor Goldthwait; the Great Esker; a well-marked and interesting moraine; and a great variety of kames. In addition, a delta terrace which was formed by a tributary of Lake Bascom and a broad high terrace on the old shore line of this same lake were observed. The scars of the Greylock landslides of August, 1901, were seen from the car. Nooning was taken at Williamstown where the members of the party enjoyed the hospitality of Williams College and were the guests of the officers of the college at a dinner served in the new College Commons.

In the afternoon, the party visited the natural bridge of the Hoosac mountains and studied the transition between the marble of the Natural Bridge quarry and the calcareous mica schists at the foot of the mountain.

It is just to add that the pleasures of the trip were enhanced by delightful weather and by the gorgeous spectacle of the mountains arrayed in autumnal colors.

ROBERT M. BROWN

WORCESTER, MASS.

WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY

THE legislature of 1909 appropriated $30,000 annually for the use of this survey. Of this sum $10,000 is a permanent appropriation, which the survey has received for several years. An appropriation of $10,000 for two years, chiefly for the use of the highway division, was repeated and a new appropriation of $10,000 annually for two years was granted for the establishment of a soil survey. The commissioners of the survey have appointed William O. Hotchkiss, formerly economic geologist of the survey, to the position of state geologist, and have placed the geological work of the survey under his immediate charge. For the present a considerable part of Mr. Hotchkiss's time is being given to the highway department, which has been under his direction.

The last legislature appointed a special committee to make suitable investigations and draw a bill providing for state aid for roads. This committee is studying the question of state aid along lines suggested by Mr. Hotchkiss and is requiring much service from him. The regular road and bridge work of the highway division of the survey has consisted in aiding towns and counties to spend more efficiently the taxes they raise for highway purposes. This has been done by bringing more business-like methods into use, and by making careful surveys, designs and estimates. The assistance thus given to local officers has been greatly appreciated by them, as it has given them technical advice and trained supervision. This work is carried on by A. R. Hirst, M. W. Torkelson and H. J. Kuelling.

A report on the peat resources of the state is in preparation by F. W. Huels, who has been working under Mr. Hotchkiss's direction.

Mr. Hotchkiss and Mr. F. T. Thwaites have been compiling a new geological map of the state, which will be issued in connection with a bulletin on the general geology of the state.

E. H. J. Lorenz has been employed to make a physiographic model of the state, under the direction of Mr. Hotchkiss and Mr. Thwaites. This model is on a scale of seven miles to the inch and will show in a graphic manner the various topographic forms. It is planned to distribute copies of this model to the various educational institutions of the state.

The natural history division of the survey has continued its work under the immediate charge of the director, E. A. Birge and the biologist, Chancey Juday. During the summer the field work for a forthcoming report on the dissolved gases and plankton of the Wisconsin lakes has been completed and the report will very shortly be ready for the press. This work has been carried on in cooperation with the U. S. Bureau of Fisheries and with financial assistance from it.

The work on the fishes of the state has been prosecuted under the general charge of George Wagner. A careful study is being made of the distribution, habits and food of the cisco of Lake Geneva. H. H. T. Jackson has spent a large part of the summer in collecting the

various species of whitefish from lakes in the northern part of the state. This collection was made in order to study the local distribution of the local species and varieties of this group of fish.

The most important new work of the survey, namely, the investigation of the soils of the state, is carried on by the Geological and Natural History Survey, cooperating with the college of agriculture and the bureau of soils of the federal government. This survey is under the general direction of Professor A. R. Whitson, of the college of agriculture. In the developed portions of the state a detailed survey is being made, the counties selected this year being Iowa, Waukesha, Waushara and a portion of Bayfield. Engaged in the field work in these areas are G. B. Jones, P. O. Wood, G. B. Maynadier, J. W. Nelson and Clarence Lounsbury from the bureau of soils, and LeRoy Schoenmann, A. H. Meyer, A. H. Kuhlman and T. J. Dunnewald from the survey and the college of agriculture.

In the undeveloped portions of the state a reconnaissance survey is being made. This is in immediate charge of Samuel Weidman, geologist on the survey, assisted by W. S. Smith, of the bureau of soils, E. B. Spraker and E. B. Hall, of the survey, and F. L. Musback, of the college of agriculture. Dr. Weidman is completing the work carried on for some years in several counties of the northwestern portion of the state, and also mapping Marinette County, in the northeastern part of the state. It is expected that the field work in all these areas will be completed during the present season.

SCIENTIFIC NOTES AND NEWS

At the recent inauguration of Dr. E. F. Nichols as president of Dartmouth College, honorary degrees were conferred on a number of college presidents, including a doctorate of laws on Dr. C. R. Van Hise, president of the University of Wisconsin, and a doctorate of science on Dr. Richard C. Maclaurin, of the Massachusetts Institute of Technology.

On the occasion of the inauguration of Dr. E. B. Bryan as president of Colgate University, the honorary degree of doctor of science was conferred on Dr. John M. Clarke, state geologist of New York, and on Dr. F. C. Perry, professor of mathematics at Williams College.

Dr. M. Treub, has retired from the directorship of the Botanical Garden at Buitenzorg.

Dr. Emil Rosenberg has retired from the active duties of the chair of anatomy at Utrecht.

Dr. Theodor Weber, emeritus professor of medicine at Halle, has celebrated his eightieth birthday.

Mr. James Britten has retired from the botanical department of the British Museum after thirty-eight years of service.

The Rumford committee of the American Academy of Arts and Sciences has made an additional grant of $300 to Professor L. R. Ingersoll, of the University of Wisconsin, for the continuation of his research on the optical constants of metals.

The Paris Academy of Medicine has awarded a prize of £160 to M. W. Haffkine for his work on inoculation against cholera.

In appreciation of his work in the Pennsylvania State Department of Health, Dr. Samuel G. Dixon, state health commissioner, was presented with a silver loving cup by the county medical inspectors of the state and chiefs of the state tuberculosis dispensaries, at a meeting held in Philadelphia on October 5.

Sir Thomas Elliott, secretary to the British Board of Agriculture and Fisheries, has been nominated by the French government to be a Companion of the Order "du Mérite Agricole."

A gold medal has been presented to Dr. Oswaldo Cruz in recognition of his services in extirpating yellow fever in Rio de Janeiro.

Dr. L. Karpinski, of the University of Michigan, is spending the year at Columbia University, working on the history of mathematics.

The magnetic survey yacht, *Carnegie*, arrived at St. John's, N. F., on September 26

and set sail on October 2, with Dr. Bauer aboard, for Falmouth, England. The vessel will then continue, under the command of Mr. Wm. J. Peters, to Madeira and return to New York, *via* Bermuda, some time next March. Dr. Bauer returns from Falmouth to Washington early in November. Every possible courtesy was extended the *Carnegie* at St. John's by the Newfoundland authorities, the governor, the premier and other prominent officials making special visits to the vessel. Mr. Carl Smith, expert on gas engines in the technologic branch of the U. S. Geological Survey, accompanied her as far as St. John's, as consulting expert.

Professor Arthur H. Blanchard, of the department of civil engineering of Brown University and deputy engineer under the State Board of Public Roads of Rhode Island, sailed on October 13 for a tour of eight months which will be devoted to an investigation of the construction and maintenance of bituminous macadam roads in France, England and Scotland.

Professor H. H. Stoek, in charge of mining engineering at the University of Illinois, has been appointed by Governor Deneen as a member of the State Mining Commission, which has been constituted to formulate desirable legislation with reference to the mining industry, and to recommend the same to the governor in anticipation of the next regular session of that body.

Mr. Charles T. Ripley, who graduated last June from the course in railway electrical engineering of the University of Illinois, has been awarded the first prize in the car design contest recently held under the direction of the John G. Brill Company, of Philadelphia. The prize consists of the John G. Brill Memorial Medal and $250. This contest was instituted by the John G. Brill Company and by them announced last fall to all schools giving instruction in electrical engineering or railway electrical engineering. The contest consisted in competitive designs for electric railway cars for city service and it was open to seniors in all schools of the country. Its purpose, as stated in the formal announcement, was to "awaken the intelligent interest of technical students in a field which offers great opportunities for personal endeavor, scientific research and a substantial reward."

Dr. Hugh Blackburn, emeritus professor of mathematics at Glasgow University, where he was appointed in 1849 the successor of Professor James Thomson, Lord Kelvin's father, and retired from active service in 1879, died on October 9, at the age of eighty-six years.

Mr. Richard Bannister, for many years chemist in the British government laboratory and known for his work on the chemistry of foods, died on September 7, at the age of seventy-four years.

Professor Cesare Lombroso, the eminent criminologist and author, died at Turin on October 18, of heart disease, at the age of seventy-three years.

The surgeon-general of the army announces that the war department has appointed permanent boards for the preliminary examination of applicants for appointment in the medical corps of the army to meet at Washington, D. C., Fort Sheridan (near Chicago), Illinois, and San Francisco, California, in addition to the usual preliminary examination boards that are assembled at various army posts throughout the United States from time to time. The permanent boards will hold sessions on the second Monday of each month. A limited number of successful candidates will be appointed first lieutenants in the medical reserve corps (salary $2,000 per annum) and assigned to army posts until the next session of the Army Medical School, when they will be ordered to attend the School as "student candidates." Applicants must be citizens of the United States, between twenty-two and thirty years of age, graduates of reputable medical schools, of good moral character and habits, and shall have had a year's hospital training after graduation, or its equivalent. Full information concerning the examination can be pro-

cured upon application to the "Surgeon General, U. S. Army, Washington, D. C."

A malaria conference attended by forty delegates from all parts of India met at Simla on October 12. Lord Minto, welcoming the members, stated that the deaths from fever in India during the last ten years averaged nearly four and a half millions. Last year the deaths were one million over the average, and the increase was believed to be due to malaria.

The third session of the permanent commission of the International Seismological Association was held at Zermatt, Switzerland, from August 30 to September 3. It was very well attended. Of the 23 countries forming the association 20 were represented, as follows: Austria, Belgium, Bulgaria, Canada, Chile, Denmark, England, France, Germany, Greece, Hungary, Italy, Netherlands, Norway, Portugal, Roumania, Russia, Servia, Spain and Switzerland. Besides the delegates, other scientists were present making the total in attendance 42. Professor A. Schuster presided, and Dr. Hepites, of Bucharest, was elected vice-president. A goodly number of scientific papers was presented, besides the reports of committees on "Instruments," "Microseismic Movements," "Earthquake Catalogue," "Finance" and "Management of the Central Bureau." The next general meeting will be held at Manchester, England, in July, 1911.

The Appalachian Engineering Association will convene in Washington, D. C., at the New Willard Hotel at 9:00 A.M., Friday, November 5. The program includes addresses by Major Wm. N. Page, of Washington, D. C., Richard H. Edmunds, editor of the *Manufacturers' Record,* Baltimore, Md., Dr. Thomas L. Watson, state geologist of Virginia, and papers by Professor R. L. Morris, of West Virginia University, Major W. J. Douglas, engineer of bridges for the District of Columbia, D. C. Weller, city engineer of Waynesboro, Pa., E. V. N. Heermance, president of the Virginia Concrete and Engineering Company, and H. Fernstrom, chief engineer of the Virginia Railway. On Saturday, November 6, by invitation of Superintendent Keppel, of the Union Terminal Company, the association will visit the mammoth interlocking plant at the new Union Station, after which Major Douglas, engineer of bridges for the district, will conduct the party to the gigantic reinforced concrete bridge on Connecticut Avenue. Headquarters will be at the New Willard Hotel and a very large attendance is promised. All engineers, geologists and persons interested in industrial development are cordially invited to attend these sessions.

It is stated in *Nature* that the inaugural meeting of the China Philosophical Society was held at Tientsin on September 18, under the presidency of the president of the Pei Yang University, Mr. Wang Shoh Lian, who, in the course of his address, pointed out the importance of the existence of such a society in the present stage of China's development, when western learning is being spread over the Empire. After the delivery of the address papers were read by Dr. G. Purves Smith, on agricultural possibilities of North China, and by Dr. Wu Lien Teh, on an example of scientific farming in Chihli.

The *Journal* of the American Medical Association states that the trachoma prize of the International Medical Congress was not awarded, but the $1,000 prize founded in 1897, by the City of Moscow, was given to Dr. O. Hertwig, professor of anatomy and comparative embryology at Berlin. The City of Paris prize of $600 was awarded to the serologist, M. J. Bordet, of Brussels. The Lenval prize of $80 was divided between Professor H. Neumann, of Vienna, and Dr. A. Grey, of Glasgow, at the international otology congress which also met at Budapest. It was decided that the international medical congresses should henceforth not be held oftener than once in four years, so that the next congress will not convene until 1913, when it will meet in London. The international committee appointed to prepare the preliminaries for the international medical congresses in future is to have its headquarters at the Hague, near which the secretary, Professor K. Wenckebach, resides. The members of the

committee are Professor Pavy, of London, M. Blondel, of Paris, as president and vice-president; the latter is also secretary of the International Medical Press Association, Dr. Maragliano, of Genoa, Dr. Müller, or Budapest, and Dr. Waldeyer, of Berlin.

UNIVERSITY AND EDUCATIONAL NEWS

THE trustees of Princeton University have accepted the gift of $500,000 of Mr. W. C. Proctor, of Cincinnati, made on condition that an equal sum be obtained for the graduate school by May 1, 1910, and that the school be not situated where the house of the president now stands.

HAVERFORD COLLEGE has received $100,000 to establish a fund for pensioning its professors.

THE General Education Board has made a conditional appropriation of $125,000 to Ohio Wesleyan University, at Delaware, O.

MRS. CHARLES E. PERKINS, of Burlington, Ia., has given $30,000 to Harvard University, to establish scholarships for students from Iowa.

HARVARD UNIVERSITY has received gifts amounting to $6,600, to be used for the immediate benefit of freshmen in Harvard College, under the direction of the assistant dean.

AN additional sum of about $40,000 has been collected in the Canton district for the endowment of Hong Kong University.

THE laboratories of The Rice Institute, at Houston, Texas, are being planned with the assistance of Professor J. S. Ames, of Baltimore; Professor E. G. Conklin, of Princeton; Professor T. W. Richards, of Cambridge, and Professor S. W. Stratton, of Washington.

WHEN the former College of Medicine of the University of Southern California became the Los Angeles Medical Department of the University of California, the former university was left without a medical department. Recently, however, the College of Physicians and Surgeons of Los Angeles was taken over and made an integral part of the University of Southern California.

DR. G. B. LONGSTAFF, of New College, Oxford, has presented £2,400 as an additional endowment for the Hope department of zoology.

MR. F. T. HAVARD has been appointed assistant professor of mining and metallurgy at the University of Wisconsin. Mr. Havard is a well known metallurgical engineer, and a frequent contributor to the technical press. He is a graduate of the Royal School of Mines, Freiberg, and has had his metallurgical experience in Germany, Chile, Montana and elsewhere.

THE University of Pittsburgh has appointed Frederick L. Bishop, '98, formerly professor of physics at the Bradley Polytechnic Institute of Peoria, Ill., head of the department of physics.

DR. G. A. VAN RYNBERK, associate professor of physiology at Rome, has been appointed professor of physiology at Amsterdam.

MR. WALTER BRUDENELL GILL, formerly scholar of Christ Church, Oxford, has been elected to a fellowship at Merton College to undertake research work in physics and to act as a demonstrator.

DR. KARL MARBE, of Frankfort, has been appointed professor of philosophy at Würzburg.

DR. K. CORRENS, of Leipzig, has been appointed professor of botany at Münster.

DISCUSSION AND CORRESPONDENCE

RECOMMENDATIONS REGARDING THE TREATMENT OF GENERA WITHOUT SPECIES, ETC.

As an outcome of the recent discussion in SCIENCE of the "Genera without Species" question, the following suggestions are offered for the consideration of zoologists and will be transmitted to the International Zoological Congress Committee on Nomenclature. They are the result of recent correspondence between Professor T. D. A. Cockerell and the writer, and have been formulated, and are here presented, by his suggestion and on lines proposed by him, with modifications that meet

his approval. They relate not only to speciesless genera, but to genera based on a species, or on a group of congeneric species, designated only by a vernacular name, unaccompanied by a diagnosis, or by an inadequate one.

1. A generic name proposed without mention of any described species is invalid unless it is accompanied by a diagnosis of such a character as to indicate that it is based on a previously known species, or group of species, that can be unequivocally identified as the basis of the diagnosis. Examples: *Gavia* J. R. Forster (1788), based exclusively on the loons, a small group of strictly congeneric species; *Fregata* and *Picoides* Lacépède (1799), based on single species obviously indicated by the diagnosis.

2. A generic name, proposed with or without a diagnosis, may be accepted if a genotype is designated merely by a vernacular name of unequivocal significance. Examples: *Plautus* Brünnich (1771), based on an unmistakable diagnosis of the great auk with the addition of the Danish vernacular name of the species; *Regulus* Cuvier (1800), proposed, without diagnosis, for the kinglets ("les roitelets" = *Motacilla regulus* Linn., as shown by Cuvier's previous (1798) use of these names).

In cases like the one last mentioned, a vernacular name is to be accepted as a genotype only when the author thus employing it has used the vernacular name accompanied by the equivalent systematic name in a previously published work, thus defining it beyond question. A vernacular name is also (and not otherwise) available as a genotype when accompanied by a reference to a work or author where it has been defined.

It is believed that these recommendations can be accepted without risk of serious complications. The first has long been a part of the A. O. U. Code; the second is not formally adopted as a rule, but is implied in the "remarks" under Canon XXXII. (p. lxi) of the Revised A. O. U. Code, which relates to *nomina nuda*. The following has a direct bearing upon this proposition:

The names of genera and subgenera given without diagnosis or any other indication of a type than a vernacular name without a citation of its previous use, as in Cuvier's "Tableau Général des Classes des Animaux," in the first volume of his "Leçons d'Anatomie Comparée" (and in other similar cases), are tenable if the vernacular name is one that has been used and defined by a then current systematic name by the same author in a previous work; the vernacular name in such cases defines the type.

J. A. Allen

American Museum of Natural History

STABLE NOMENCLATURE PRACTICALLY UNATTAINABLE

To the Editor of Science: I have read with much interest Mr. Jonathan Dwight's article in a recent number of Science on "The Burden of Nomenclature." While I am in sympathy with this article, and with the general tendency of modern systematic biologists to formulate rules and codes to govern the application of generic and specific names, I wish to emphasize the point that no matter how perfect such a code may be we can not hope that stability will be the immediate result. A very important factor in the application of names is the study of the organisms to which the names are applied. The perfect code would indicate the application of the names when the study of a group of organisms had been completed. When the study of all organisms has been completed we may hope for a more or less stable nomenclature. Until that time we must accept as inevitable a certain amount of change as groups are critically studied. It is true that much of the change during the present era is due to the use of different codes, to misinterpretation of rules and to what some are pleased to call the juggling of names, that is, an attempt to fix names without carefully studying the group concerned. But aside from this there is what we must accept as legitimate and inevitable change due to increased knowledge of the organisms and their nomenclatorial history. It is not necessarily an adverse criticism of a code that different editions of a list show changes in nomenclature. In my own work I have found that absolute stability of nomenclature is practically unattainable. Starting with the traditional application of names in a given group, investigation may show that many of these names have been misapplied. Two authors studying the same group at different times may apply the names in different

ways even when following the same code. This difference may be due to the fact that one author has more abundant material upon which to base his conclusion, or it may be due to a difference of opinion as to the relation of the organisms, or in the interpretation of the work of others. Differences in the application of names due to these causes are not the result of imperfections in the code followed, and no code can eliminate such changes. In fact it would be very unwise to attempt such elimination. Students must not be handicapped in serious study. On the other hand, it is well to discourage the study of nomenclature as apart from the study of organisms. I believe it is impossible for any person or any committee, to prepare a list of organisms which shall be permanent; partly because such person, or committee, may not be sufficiently familiar with the organisms, and partly because the knowledge concerning these organisms is ever increasing. The value of a code of nomenclature should be judged by its usefulness in determining the application of names, rather than by the changes that may result.

A. S. Hitchcock,
Systematic Agrostologist
Department of Agriculture,
Washington, D. C.

THE MAGNETIC STORM OF SEPTEMBER 25, 1909

An exceedingly severe magnetic storm was recorded at the Cheltenham Magnetic Observatory on September 25, 1909, the first indications appearing as a slight disturbance of the magnets at 3:27 A.M., 75th meridian time.

The period of greatest disturbance began at 6:39 A.M. and lasted until about 4 P.M., and during most of this interval the movements of the recording magnets were so sudden and of so large amplitude that the spots of light failed to produce any impression on the photographic paper, except in the case of declination, where a partial record was secured.

From 6:39 to 8:17 A.M. the changes in the earth's magnetism were so great that the magnets were deflected far out of their normal positions and the spots of light passed beyond the limits of the photographic paper. During this interval the magnets which furnish a record of the changes in vertical intensity were upset by the variations in the earth's magnetism. These magnets are balanced on a knife-edge or a pair of fine points and are extremely sensitive.

As there was no observer on duty until 8:00 A.M. no estimate can be made of the changes during the interval of greatest disturbance. The actual ranges of the magnetic elements during this storm are therefore unknown.

Two complete magnetographs are in operation at this observatory and are arranged to give continuous photographic records. Each consists of three instruments arranged to give record of the variations in the three elements, declination, horizontal intensity and vertical intensity, respectively. One of the magnetographs, the "Adie," is also fitted with telescopes and scales, so that the position of each magnet may be observed and the actual value of the element determined at any instant. These scales cover a range in the position of the magnet about two and one half times as great as that covered by the paper.

DECLINATION (*West*)

75th mer. time h m	Value ° ′	Remarks
6 39 A.M.	6 29	Off paper.
8 00	6 46	Eye reading.
8 05	8 22	Eye-reading maximum.
8 19	3 25	Minimum.
1 18 P.M.	4 44	
1 52	6 29	
1 58	6 54	
2 38	6 40	
	5 36	Normal value.

HORIZONTAL INTENSITY

75th mer. time h m	Value c.g.s.	Remarks
8 05 A.M.	.17900	Estimated.
9 22	.19680	
10 41	.19187	Eye-reading minimum.
10 52	.19336	
1 19 P.M.	.20343	Eye-reading maximum.
1 58	.19397	
2 38	.19351	Change of 901 gammas in
2 43	.20252	5 minutes.
2 46	.19481	
3 16	.20301	
	.19878	Normal value.

After 8:00 A.M. eye-readings were secured which show that this is by far the largest storm which has occurred since the records of this observatory began, in April, 1901. The following table will give a general idea of the magnitude of the disturbance.

It will be seen that there was an observed range in declination of nearly 5° and in horizontal intensity of 1,156 gammas and an estimated range of over 2,400 gammas, about one eighth of the horizontal intensity. For comparison, it may be stated that in the storm of October 30–31, 1903, which was the largest recorded at Cheltenham before this one, the range in declination was 1° 37′ and in horizontal intensity about 500 gammas.

J. E. Burbank

Coast and Geodetic Survey
Magnetic Observatory,
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SCIENTIFIC BOOKS

SOME RECENT BOOKS ON CHEMISTRY

Of the making of text-books there is no end; this season brings an abundant crop. Of those to be considered in this review two are text-books of inorganic chemistry.

Any book written by Professor Holleman repays close study. The English translation of his "Text-book of Inorganic Chemistry"[1] is well known in this country. It is inorganic chemistry for advanced students written from a physical-chemical standpoint. Some of the best known modern text-books seem mainly concerned with electrolytic dissociation and the phase rule, banish the periodic system to a page or two at the end of the book and—like nearly all our older books—practically ignore thermo-chemistry. As most French books practically ignore everything but thermo-chemistry, it follows that many students can not read a French book on chemistry intelligently. Professor Holleman gives due space to electrolytic dissociation, phase rule and thermo-chemistry, retains the periodic system and applies them all in the text. A student trained by this book can intelligently read any of the present methods of interpreting chemical phenomena. The preface to this edition says:

> The portions on the phase rule, spectroscopy, radioactivity, iron-carbon system and metal-ammonia compounds have been largely rewritten by the author, and the chapters on colloids, experimental determination of equivalent weights and unity of matter are entirely new. Professor Werner has kindly approved the chapter on metal ammonia compounds.

Teachers who do not care to use so advanced a book in their classes will find it invaluable for study and reference.

What has been said of the plan of Holleman's book applies also to the "General Chemistry" of Professor Alexander Smith.[2] It is a broad comprehensive book written in a catholic spirit on the same general lines as that of Holleman. It is somewhat simpler than the latter and better fitted for the American student in arrangement. The book is so well known that it needs no further comment here; its friends will be glad to see that it has appeared in German with an appreciative introduction by Professor Haber.

Of the other books to be considered in this review five are about inorganic preparations and two are manuals of qualitative analysis. These numbers are significant, indicating a general change in methods of laboratory instruction. Making inorganic preparations was an important part of the work in the laboratories of Wöhler, Bunsen and the other great teachers of that time. With the increase of interest in organic work, inorganic preparations were neglected more and more till twenty

[1] "A Text-book of Inorganic Chemistry," by Dr. A. F. Holleman, Professor Ordinarius in the University of Amsterdam. Issued in English in cooperation with Hermon Charles Cooper. Third English edition, partly rewritten. New York, John Wiley and Sons, 1908.

[2] "Einführung in die allgemeine und anorganische Chemie auf elementarer Grundlage," von Dr. Alexander Smith, Professor der Chemie an der Universität Chicago. Unter Mitwirkung des Verfassers übersetzt und bearbeitet von Dr. Ernst Stern. Mit einem Vorwort von Professor Fritz Haber. Karlsruhe i. B., G. Braun, 1909.

years ago there were few laboratories in America or Europe which included them in regular student work. The publication of Erdmann's "Anleitung zur Darstellung inorganischer Präparate" in 1891 marked the beginning of a new era. Similar books quickly appeared in this country and in Germany, each adapted to local conditions. All of these were like Erdmann's first book, simply collections of recipes for making different substances, yet the work was very valuable for many reasons, but chiefly because the students liked it; in the present reviewer's own experience students whose interest in analytic work was languid became deeply interested in the preparations and in some cases the interest once awakened extended to chemistry as a whole, and determined the choice of post-graduate work.

Of late several authors have endeavored to write manuals of preparation on a more scientific basis. The books of the two who perhaps have succeeded best are on our list. Professor Blanchard's little manual[3] is written for beginners and is to precede analytical work. It is a selection of simple preparations of compounds generally of industrial importance. The notes for each exercise are divided into three parts: (1) A discussion of object of exercise and principle of method, (2) explicit working directions, (3) questions for study which involve additional laboratory experiments, the consulting of text-books and original reasoning. It is assumed that the student has an elementary knowledge of the electrolytic dissociation theory and of the principle of mass action. The present reviewer used Professor Blanchard's book with beginners last winter with very encouraging results. The attention of teachers is specially called to this book.

The second book referred to is that of Professors Heinrich and Wilhelm Biltz,[4] whose German manual has been ably translated by Professors Hall and Blanchard. This is a book for chemists and advanced students, not for college students. The authors describe and discuss 171 preparations—few of them easy—divided into seven groups. Group I. contains the elements including reductions by carbon, by aluminothermy, by potassium cyanide, etc. Under group II. changes of condition are considered, including allotropy, passive condition, colloidal state and adsorption compounds. Group III., simple binary compounds. Group IV., compounds containing a complex negative component; such as sodium peroxide, sodium hydrazoate, potassium perchlorate. Group V., compounds containing a complex positive component; including ammonium salts and the metal-ammonia compounds. VI., complex non-electrolytes; including acid-chlorides, esters and metal-organic compounds. VII., preparation of the rare elements from their minerals.

To aid in the study of the theoretic relations brief general discussions are scattered throughout the book, as well as references to the original literature and to text-books of inorganic and theoretical chemistry. The book is admirable; it is by far the best and most thorough work on the subject which has appeared.

The book of Messrs. Hanson and Dodgson[5] treats of inorganic preparations, volumetric and gravimetric quantitative analysis and very elementary qualitative analysis. It is one of those curiously proportioned English books written to enable students to pass a given examination, in this case the London Intermediate Science Examination. While the book is well written and is doubtless well adapted for its special purpose, it can be of little interest to teachers here.

[3] "Synthetic Inorganic Chemistry, A Laboratory Course for First-year College Students," by Arthur A. Blanchard, Ph.D., Assistant Professor of inorganic chemistry at the Massachusetts Institute of Technology. New York, John Wiley & Sons, 1908.

[4] "Laboratory Methods of Inorganic Chemistry," by Heinrich Biltz, University of Kiel, and Wilhelm Biltz, University of Göttingen. Authorized translation by William T. Hall and Arthur A. Blanchard, Massachusetts Institute of Technology. First edition. New York, John Wiley & Sons, 1909, pp. 258.

[5] "An Intermediary Course of Laboratory Work in Chemistry," by Edward Kenneth Hanson, M.A., and John Wallis Dodgson, B.Sc. London and New York, Longmans, Green & Co., 1908.

Professor Lee's book[6] is written for beginners. There are many experiments, most of which are those performed in most laboratories during the first years. Many however would come under the head of preparations, while others are quantitative or physical-chemical. The experiments are well chosen; the only adverse criticism to the book is that while the text is generally very clear and simple, Professor Lee has introduced matter from chemical journals, some of which would be out of place even in a text-book for advanced students. A few omissions and some minor revisions would remove the defects from this otherwise excellent manual.

Professor Stoddard's book[7] is a collection of rough quantitative experiments illustrating the gas laws, gas densities, specific heat, analysis of gaseous compounds and of a number of metal derivatives. The experiments are well selected and are intended for beginners.

The remaining books on our list are two manuals of qualitative analysis, one for colleges the other for schools; the first is by Professor Tower;[8] it is a clear, thorough yet brief exposition of qualitative analysis explaining reactions with help of the theory of electrolytic dissociation. The methods of separation given are very good, Noyes's method of separating antimony and the separation of strontium from calcium by amyl alcohol being the only ones not generally known. The present reviewer has used the Noyes method from the time of its publication and can join Professor Tower in commending it.

[6] "A Text-book of Experimental Chemistry with Descriptive Notes for Students of General Inorganic Chemistry," by Edwin Lee, Professor of Chemistry in Allegheny College. Philadelphia, P. Blakiston's Son & Co., 1908.

[7] "Quantitative Experiments in General Chemistry," by John Tappan Stoddard, Professor of chemistry in Smith College. New York, Longmans, Green & Co., 1908.

[8] "A Course of Qualitative Chemical Analysis of Inorganic Substances, with Explanatory Notes," by Olin Freeman Tower, Ph.D., Hurlburt professor of chemistry, Adelbert College of Western Reserve University. Philadelphia, P. Blakiston's Son & Co., 1909.

Mr. Segerblom's[9] book is much fuller in detail than that of Professor Tower's. It contains no physical-chemical explanations, and no new methods of separation. The separation-methods are arranged in tables and there are many pages of equations; in short the method employed in the more conservative German laboratories forty years ago. The contrast between methods as shown in these two manuals is striking, though doubtless—given a good teacher and a bright student—good results are attained by both.

E. Renouf

Allgemeine Physiologie. Ein Grundriss der Lehre vom Leben. By Max Verworn. Fifth edition, revised. Jena, G. Fischer. 1909. Pp. 742; illustrations 319.

Fifteen years after its first appearance the fifth edition of Verworn's valuable book is now issued. It has here received the most extensive of its successive revisions. The final result of the elimination and addition of matter represents an increase of 158 pages over the first edition and of 90 pages over the fourth edition.

In discussing the method of physiological investigation the author makes an interesting presentation of the logic of causation. Long ago John Stuart Mill said that, philosophically speaking, the cause of a phenomenon is the sum total of its conditions. Yet physiologists are constantly guilty of the logical sin of selecting a single condition and setting it up as *the* cause. Verworn rightly inveighs against this, but goes to the extreme of eliminating altogether from his book the idea of causes of physiological facts. He also takes occasion to rewrite his section on the physical world and mind, and to hammer the vitalists anew. The newer views regarding proteins are presented, following especially Emil Fischer's work. A new section is devoted to the functions of membranes and the osmotic characteristics of cells, while osmotic pressure is

[9] "Laboratory Manual of Qualitative Analysis," by Wilhelm Segerblom, A.B., Instructor in chemistry at the Phillips Exeter Academy. New York, Longmans, Green & Co.

now given its rightful place as one of the important conditions of life on the earth's surface. A paragraph is devoted to the mutation theory.

Many of the revisions in the present edition occur in the chapter devoted to stimuli and their actions. In a rediscussion of the action of light rays on living substance the results of Hertel's work are presented approvingly, and the general conclusions are reached that all living substance is sensitive to light as to heat; that light rays act upon living substance primarily by altering metabolism through reduction processes; and that the question whether the rays of any portion of the spectrum are physiologically active or not, is merely a question of their intensity as radiant energy, combined with the fact that the possibility of the absorption of the rays by organisms is inversely proportional to the wavelength. Brief sections are devoted to the physiological action of Röntgen and of Becquerel rays. The discussion of fatigue is extended. New sections deal with the refractory stage of living substance in its relation to stimuli, and the apparent increase in irritability which living substance experiences in the early stages of stimulation. Great stress is laid on the importance of Fröhlich's explanation of this latter phenomenon. It may well be doubted whether the author has not overestimated the value of this explanation.

The final and heretofore long chapter on the mechanism of life is still further extended in the light of a fuller statement of the biogen hypothesis. New sections deal with the question of the rôle of oxygen in metabolism, the self-regulation of metabolism and the law of mass action, and functional and cytoplastic metabolism. In a revision of the treatment of inhibition the question whether the inhibiting stimulus acts by augmenting anabolism or depressing katabolism is answered in favor of the latter view. Godlewski's experiment, in which non-nucleated pieces of the ovum of a sea urchin were fertilized by the spermatozoa of a crinoid, and the resulting larvæ possessed purely maternal characteristics, is regarded as an *experimentum crucis* demonstrating to a certainty the incorrectness of the theory that the hereditary substance is localized in the cell nucleus. The assumption that the nucleus is the organ of oxidation for the cell is dismissed as "blosse Phantasie."

It is only natural for an author to be best acquainted with, and to look with favor on, the products of his own laboratory and his own country. No one can justly minimize the invaluable contributions of Germany to general physiology. But general physiological research is now strikingly international, and it is to be regretted that in so important a book as Verworn's, the literature has not been more widely canvassed. American, English and French work is sadly neglected. Thus, of the host of American investigators, only nineteen in all are cited, and of those who have contributed during the past ten years of great activity, only eight. Notwithstanding this lack, Verworn's book is still the most comprehensive and stimulating of all works on general physiology.

FREDERIC S. LEE

COLUMBIA UNIVERSITY

The Opisthobranchiate Mollusca of the Branner-Agassiz Expedition to Brazil. By FRANK MACE MACFARLAND. Stanford University Publications, University Series no. 2, 1909. 123 pp., 8vo, pl. i–xix.

During the work of the Branner-Agassiz expedition to Brazil in 1899 a small collection of Opisthobranchiate mollusca was made by Mr. A. W. Greeley, a study of which forms the basis of the present paper. This comprised seven species of which five are regarded as new, one being a *Pleurobranchus* and the others nudibranchiata.

Following the introduction the author gives a list, with references, to thirty species of Opisthobranchs, all yet reported from the east coast of South America. Although this doubtless comprises only a moiety of the species which may be expected to occur and is too small to base extended generalizations upon, yet it indicates a fact already definitely shown by collections of other groups of mollusks—that the Antillean fauna extends for a considerable distance southward along the coasts of Brazil without interruption by the fresh waters of the Amazon, which points to the

further conclusion that the present distribution of the litoral fauna was completed before the Amazon bore its present geographical relations. If it were otherwise the vast mass of the river waters would have formed an insurmountable barrier to the southward extension of marine forms living in shallow water.

The main body of the paper consists in an anatomical study of two species of *Tethys* and the new species above referred to. The investigation is carried out in great detail, the most noticeable feature in the genus *Tethys* being the determination of nerves issuing from the pleural ganglion and anastomosing with pedal nerves in each case, contrary to the results announced by some investigators from studies of Mediterranean species of *Tethys*. Excellent figures are given of the anatomy, especially of the nervous and alimentary tracts, and comparisons instituted with the results of other investigators. On the whole the paper is creditable to the author and to the university under whose auspices it appears, and will prove, we hope, the forerunner of other contributions to a subject which has hardly received hitherto its proper meed of attention. WM. H. DALL

SUMMARIES OF FOUR OPINIONS (6, 7, 8, 12) BY THE INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

THE following summaries of recent opinions by the International Commission on Zoological Nomenclature are published for the information of persons interested in the points in question. It is expected that the full details of the arguments will be published later in connection with certain other cases now under consideration. These summaries do not give the reservations made by certain commissioners, but these reservations will be presented in the final publication.

6. *Genus* A *Linnæus, 1758, with two species* Ab *and Ac*.—When a later author divides the genus *A*, species *Ab* and *Ac*, leaving genus *A*, only species *Ab*, and genus *C*, monotypic, with species *Cc*:

The second author is to be construed as having fixed the type of the genus A. [See Article 30.]

Vote: Affirmative 14; negative 0; not voting 1.

7. *The interpretation of the expression* "n. g., n. sp." *under Article 30* (*a*).—The expression "n. g., n. sp." used in publication of a new genus for which no other species is otherwise designated as genotype, is to be accepted as designation under Article 30 (a).

Vote: Affirmative 9; negative 4; not voting 2. [As the vote on this case is not unanimous, the point in question may possibly come up for consideration at the next meeting of the commission.]

8. *The retention of* ii *or* i *in specific patronymic names, under Article 14* (*c*) *and Article 19*.—Specific patronymics originally published as ending in *ii* (as *schrankii, ebbesbornii*) are, according to Article 19, to be retained in their original form, despite the provision of Article 14 (c) which provides that they should have been formed with only one *i*.

Vote: Affirmative 11; negative 2; not voting 2. [As the vote on this case is not unanimous, the point in question may possibly come up for discussion at the next meeting of the commission.]

12. *Stephanoceros fimbriatus* (*Goldfuss, 1820*) *vs.* S. eichhornii *Ehrenberg, 1832*.—The generic name *Stephanoceros*, 1832, is to be used in preference to *Coronella*, 1820 (preoccupied, 1768); the specific name *fimbriatus*, 1820, takes precedence over *eichhornii*, 1832, which is admittedly (Ehrenberg, 1832b, 125, and 1838a, 400–401) *fimbriatus*, 1820, renamed. Ehrenberg was right in rejecting *Coronella*, 1820, but in error in rejecting *fimbriatus*, 1820; no reason is apparent for perpetuating his error.

Vote: Affirmative 14; negative 0; not voting 1.

C. W. STILES,
Secretary of Commission

SPECIAL ARTICLES

CARBON DIOXIDE AS A FACTOR IN HEART BEAT

CARBON dioxide when distributed uniformly in the blood in large quantities exerts a definite injurious effect on the heart. In the normal circulation, however. the right heart

contains about eight volumes per cent. more CO_2 than the left heart. It seemed to us that the electromotive force resulting from the difference in potential might exert an influence differing from the ordinary pharmacological action of the carbonates and be, at least, a factor in the maintenance of heart beat.

The exact condition of the CO_2 in the blood is not known. The fact that part is in solution and part is in combination renders a mathematical presentation only approximate.

Eight volumes per cent. CO_2 equals 80 volumes per liter. Calculated from H as 0.0896 grams this would equal 1.9712 grams CO_2 and equal 2.7777 grams of H_2CO_3, or approximately the equivalent of $N/10$ H_2CO_3 between the left and the right sides of the heart. Assuming this to be ionized we should have an electromotive force represented by the formula below.

(Jones) $$\pi = .0002\frac{u-v}{u+v}T\log\frac{C_1}{C_2}$$

at 25° C. or since the valence of the positive negative ions may vary

(Jones) $$\pi = \frac{\frac{c}{v}-\frac{a}{v'}}{c+a}0.0002T\log\frac{P_1}{P_2}.$$

To test the theory we perfused several mammalian hearts (cats') with blood oxygenated on one side and carbonated on the other. The technical difficulties of keeping the two separate were not completely overcome, but sufficiently so to convince us that there was no effect aside from the usual carbonate action.

Parts of the turtle ventricle or the whole heart was split so that each end could be immersed in a separate saline bath through which CO_2 and O could be forced. One end was bathed in CO_2 and the other in O. The whole was so arranged that a tracing could be recorded.

The results obtained were no different from those with the mammalian heart. The addition of $NaHCO_3$ gave the same action irrespective of whether it was added to either or both sides of the heart. Our results would indicate that the difference in CO_2 between the left and right sides of the heart has no influence on the rate or strength of the beat of the isolated organ.

This does not preclude the probability that CO_2 has an influence direct or indirect on the heart beat of the intact animal. Its known action on the dissociation of hemoglobin and the probable similar action on other salts renders the view highly probable that carbon dioxide is a factor in the automatism of the heart.

HUGH McGUIGAN,
R. H. NICHOLL
ST. LOUIS,
October 6, 1909

THE INFLUENCE OF CHEMICALS IN STIMULATING THE RIPENING OF FRUITS

VARIOUS chemical and physical methods of bringing on latent physiological processes in plants have long been known. Buds have been brought into full blossom for commercial purposes weeks before their natural time by the application of anesthetics, and Molisch has lately accomplished the same result by the use of hot water. The Arabs have also applied cloths moistened with vinegar to bunches of dates in order to "sweeten up" retarded fruits.

Following this lead, the writer has succeeded in ripening the fruit of a seedling date into a perfect commercial product in less than three days. The flavor of the chemically stimulated fruit is fully equal to that of the best naturally ripened, and a much greater evenness of ripening is obtained than when left on the tree. The sprays of fruit are subjected to the vapor of acetic acid for twelve or fifteen hours. At the end of this time they have become transparent nearly to the seed and will then ripen naturally without further treatment. The process can be accelerated by exposing them to sunshine, or more rapidly by heating for some hours to forty-five degrees centigrade. The process, it is anticipated, will permit the shipping of dates green and ripening them at their destination as bananas are now handled.

The fresh ripe date is very soft and prone to sour quickly, while the unripe fruit is very firm and not easily bruised. Furthermore, the

ripe, fresh date deteriorates very rapidly in flavor, due largely to the inversion of the cane sugar. For example, the unripe fruit of the seedling used in these experiments contains fifteen or twenty per cent. of cane sugar when ready to ripen, but very soon after complete ripeness this cane sugar disappears. This is due to the release of the intracellular invertase at the time of ripening. Much of the fine quality of the delicious Deglet Noor date is due to the nearly complete absence of invertase, which allows the cane sugar to remain permanently as such. By artificial ripening at their destination, the more inferior invert sugar varieties can be placed upon the table of the distant consumer with their maximum quota of cane sugar and consequently of flavor.

After moderate treatment with acetic acid, the tannin of the date has not yet become entirely insoluble but all astringency disappears in the next few hours. The intracellular invertase, however, passes into solution to quite an appreciable extent immediately after the treatment, and probably other intracellular or insoluble catalytic agents, are released simultaneously. The ripening processes are initiated not only by acetic acid, but also by a number of other chemicals such as acetic ether vapor, which acts practically as well as acetic acid but greatly impairs the flavor. Soaking some hours in a solution of potassium acetate stimulates the process in a very marked way but ammonium acetate has very little effect. Potassium sulphate shows no action. Oxalic acid shows a slight effect, while its homologue, succinic acid, has a very marked action. Benzoic and salicylic acids, and the acid amides (at least as regards acetamid) act promptly. The vapor of hydrochloric acid is without effect, but dates exposed to this acid for two days responded to acetic vapor. A detailed study of the effects of various groups of reagents is being made and the results will be published as soon as completed.

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NOTES ON THE PARASITISM OF CYTODITES NUDUS AND HÆMAPHYSALIS CHORDEILIS[1]

I. *Cytodites nudus.*

Among the many varieties of acariasis found in the United States, that produced by *Cytodites nudus* is comparatively rare. Furthermore, in the cases where *Cytodites* has been mentioned in this country, in Europe and in Australia, it has usually been described as a parasite of the trachea, lungs, air sacs and other respiratory passages of fowl and pheasants. Gerlach,[2] however, has attributed to it enteritis of poultry, and Zundel[3] considers these mites as the causative agents of enteritis and peritonitis, and Holzendorff[4] also found *Cytodites* embedded in the liver and kidneys of diseased fowls. It is the purpose of the present note to describe the conditions of infection observed by the writer in two cases of acariasis caused by *Cytodites nudus*, occurring in the yards of the Rhode Island Agricultural Experiment Station at Kingston.

The first case was that of a female golden pheasant. On December 21 it was observed that the bird was unable to walk, ate little, and showed a slight diarrhea. On December 22 a dose of castor oil was administered. From this time on the bird failed in strength, but lost very little flesh until it died on January 4, on which date the *post mortem* examination was made.

The internal organs were, as a whole, normal, except for the lungs, which were slightly congested. The heart was normal, though the most of the pericardial fluid appeared to have escaped into the thoracic cavity. Inside the pericardium, and on the surface of the heart itself, were a large number of round whitish bodies, about .5 mm. in diameter, which were recognized upon microscopic examination as identical with *Cytodites nudus*. Upon

[1] Contribution No. 6 from the Division of Biology of the Rhode Island Agricultural Experiment Station, Kingston, R. I.

[2] Gerlach, *Magazin für Thierheilkunde*, Berlin, 1859.

[3] Zundel, *Journ. de Med. Veterinaire*, Lyons, 1864.

[4] Holzendorff, *Archiv für wissensch. und prakt. Theilk*, 1885.

further examination these organisms were found in the air sacs, being especially numerous in the interclavicular. Upon examining the abdominal cavity it was found that, while the proventriculus, gizard, spleen, pancreas, ovaries, ceca, duodenum and small intestines were normal, the gall bladder was perforated at several points, so that the fluid had spread into the abdominal cavity. On the surface of the gall bladder, and on the surface of the liver, spleen, kidneys and intestines, as well as on the mesenteries and peritoneum, great numbers of *Cytodites* were found. It seems very probable that death was caused by these mites, which had, in this instance, perforated both the pericardium and the wall of the gall bladder.

The second case of infection with *Cytodites* was that of a fowl coming from a private poultry yard near the experiment station. This bird also had been sick for several days, and finally died on January 7. The conditions found upon *post mortem* examination were similar to those described above except for the fact that the gall bladder and the pericardium were not perforated, and the number of *Cytodites* clustered on the internal organs was much greater than in the case of the pheasant.

II. *Hæmaphysalis chordeilis.*

Although members of the genus *Hæmaphysalis* have not been uncommon in the southern states, their occurrence in the northern states is far less common. While *Hæmaphysalis chordeilis* has been reported by Banks[6] as having been found on a nighthawk, caught at Milton, Mass., and from a turkey at Taftsville, Vt., there is no case on record in which this parasite has in a single locality increased in numbers so as to be a menace to the raising of domestic poultry. The purpose of the present note is to place on record a case of this sort occurring in June, 1909, at Norwich, Vt.

At this time the attention of the Rhode Island Agricultural Experiment Station was called to the case of Mr. A., of Norwich, whose turkeys were dying as the results of the parasitic attacks of a large tick. The writer secured specimens which were identified by Dr. Banks, of the Bureau of Entomology, and by Professor Barlow, of the Rhode Island State College, as *Hæmaphysalis chordeilis*. Further data regarding the outbreak are given below:

The ticks were first observed by Mr. A. in the later part of May, when his young turkeys were about one week old. Then the parasites were found especially in the region of the neck, where they seemed to do most of their biting and sucking. Most of the birds that were infested carried from seventy to eighty full-grown ticks, as well as many more immature forms. In order to rid his birds of the ticks, Mr. A. tried insect powders without avail. He then tried lard and kerosene oil, but found that it did no good; indeed, "when the ticks were put into it they lived for seven days." Finally he got rid of them by picking them off the young birds, but not until forty of a flock of forty-six young turkeys had died.

The source of this infection is not known. It appears probable, however, that it entered Mr. A.'s flock with turkeys which he bought early in the spring. Mr. A. had no fowls, so they could not have been the source of the trouble. The above hypothesis gains evidence from the fact that Mr. A. sold some of his recently purchased turkeys to a neighbor, in whose flock the ticks also subsequently appeared.

One interesting consideration in connection with the present case is that Dr. Banks reported *Hæmaphysalis* from Taftsville, Vt., only a few years ago. Mr. A. states that he never received any birds from Taftsville, but it is apparent that the interchange of poultry stock in Vermont gives ample opportunity for the dissemination of this destructive parasite.

In order to prevent further spread it would seem important that the center of infection be located and proper measures taken to stamp out the trouble before the parasite enters other regions of the state of Vermont, or is disseminated into adjoining states.

Philip B. Hadley

[6] Nathan Banks, "A Revision of the Ixodidæ or Ticks of the United States," Bulletin No. 15, Bur. Entomol., U. S. Dept. Agriculture, 1908.

THE WINNIPEG MEETING OF THE BRITISH ASSOCIATION

SECTION H—ANTHROPOLOGY

For twenty-five years it has been the policy of the British Association for the Advancement of Science not to confine its annual meetings to the British Isles. Pursuant to this truly imperial policy a meeting was held in Winnipeg, Manitoba, August 25 to September 1, 1909. This was the third meeting on Canadian soil, the first having been held at Montreal in 1884, and the second at Toronto in 1897. To the Winnipeg meeting the officers of the American Association for the Advancement of Science were invited as guests, while a general invitation was extended to all its members and fellows. These invitations were not only very highly appreciated, but also accepted by a considerable number of American men of science who are only too glad of an opportunity to attend a meeting of the British Association without being compelled to cross the Atlantic.

By a curious coincidence the anthropological interests of each association are represented by a Section H, which had held its first meeting in Montreal—that of the American Association in 1882 and that of the British Association in 1884. The sectional president at Winnipeg was Professor John L. Myres, of the University of Liverpool. The full text of his address on "The Influence of Anthropology on the Course of Political Science" has appeared in *Nature* of September 23. In it he emphasizes the double place held by anthropology in the general scheme of knowledge. On the one hand it may be considered as a department of zoology, or geography; on the other as embracing whole sciences such as "psychology, sociology, and the rational study of art and literature." From ancient Greece, the renaissance, and the periods of great discovery and colonization, numerous authors were cited "to show how intimately the growth of political philosophy has interlocked at every stage with that of anthropological science." The history of the subject for the last fifty years shows how European colonization and anthropological discoveries have united to establish a matriarchal theory of society as a rival of the patriarchal, and then to confront both with the phenomenon of totemism. Anthropology may yet furnish the facts about human societies that will make it possible for the student of political science to measure the forces which maintain or destroy states. The address closed with a strong plea for an ethnological survey of Canada before it is too late.

The reports of various committees formed an important part of the program. The committee appointed to investigate the lake villages in the neighborhood of Glastonbury reported that owing to the amount of work required in compiling and arranging the details of the monograph on Glastonbury lake village, it was found inexpedient to resume excavations this summer on the new site at Meare. The expenses incurred in the preliminary excavations carried on at Meare last summer have already been paid by Mr. Bulleid, and, consequently, no part of the £5 grant made by the association has been expended. The committee have, therefore, to recommend that this grant be renewed, together with at least £30 in addition. With a sum of £35 assured, and the number of private contributions already announced, the committee hope to make considerable progress in excavating the Meare lake village during the summer of 1910. Judging from the discoveries already made and recorded (Tenth Report, Dublin Volume, p. 414), this new lacustrine site promises to be richer in archeological remains than even Glastonbury.

The committee appointed to ascertain the age of stone circles have obtained evidence bearing on the probable date of the monument at Avebury, which is ascribed to the neolithic period. Sectional and other plans of all the parts excavated have been prepared with great care and a large number of photographs were taken. The grant of the association, together with most of the money raised by subscriptions, having been expended, the committee ask for a new grant of £75, and for reappointment with leave to invite subscriptions commensurate with the costliness of the excavations due to the huge scale of the earthworks.

The committee appointed for the collection, preservation and systematic registration of photographs of anthropological interest, reported that, as no grant was made to it last year, and the balance in hand has all been expended, no additions to the collection have been made since the last meeting of the association, as it is useless to accept prints for the collection, if it is not possible to mount and store them. The committee, first appointed in 1899, has received nothing beyond the initial grant of £10, which has now all been expended. Over 1,000 photographs have been received and mounted, while in addition to this other collections, numbering some 3,000 subjects,

have been registered, catalogued and made available to students.

President Myres reported for the committees on excavations of Roman sites in Great Britain and on the preparation of a new edition of "Notes and Queries on Anthropology." The latter will appear within the coming year.

The committee on archeological and ethnographical researches in Crete presented the following *interim* report from Mr. C. H. Hawes, who was able to return to Crete in the spring of 1909. In view of the important results outlined in this report, and of the possibility of a longer stay in Crete than Mr. Hawes originally contemplated, the committee asks to be reappointed, with a further grant.

REPORT FROM MR. C. H. HAWES

A piece of good fortune was met with at the opening of this season's work. During October, 1908, four skulls, two portions of other crania, several pelvic and long bones, came to light in the course of deepening a well in the alluvial bank of an ancient river ten minutes east of Candia. The argillaceous deposit in which they lay had acted as a natural plaster of Paris, and we are now in possession of human osseous remains of not later than the Middle Minoan I. period, in the most extraordinary state of preservation. Complete measurements and observations have been made upon these, and I hope to publish them at an early date with a comparison of those discovered by Dr. Duckworth in 1903.

In attacking the problem of how to discover or uncover the ancient stratum among the modern people, I have addressed myself to the task of finding out and isolating, if possible, alien elements of historical times. Representatives of Turkish and old Venetian families have been approached, and genealogical, traditional and historical information garnered, with a view of testing them anthropometrically. For example, one village at which I am to stay this week claims to contain only descendants of Venetians who have strictly refused exogamous marriages. A small Armenian colony has existed in Candia since the Turkish occupation in 1669, and inasmuch as the Armenoid type of head is met with in the east end of the island, whether of historic or prehistoric date, this little band of settlers is being measured. Albanian influence has been suspected in Crete, and rightly so, since for various reasons the Turkish Janissaries in the island included large numbers of these Europeans, and considerable mixture resulted. In view also of the Dorian occupation of Crete and the belief in certain quarters that Illyria largely furnished the Dorian hosts, it seemed important to get at the Albanian type. Records of these and other peoples to be met with in the island were in my possession, but I was anxious to attempt the method of race analysis by contours of the living head. During my short stay at Athens I was able, by the aid of Mr. Steele, of the Lake Copais Company, to pay a flying visit to an Albanian village in the mountains to the northeast of the lake. There, in the village of Martino, reputed to be the purest of five such, I measured forty individuals and obtained contours of their heads by means of an instrument which I had just completed.

The problem has been attacked from another direction. What modification of the cephalic index and the shape of the head has been effected by artificial deformation or formation of the head? I am indebted to Professor Macalister for calling my attention to the importance of this factor. It is a custom which is far more prevalent than is dreamed of, and thousands of people in this island, mostly of the male sex, are unaware of a custom which is universal except among the Mussulmans and the better educated minority of urban population. As to the reason and methods of such head shaping, I hope to enter into details in a separate paper. The first object was to gauge the effect on the cephalic index and the contours. At the outset it is necessary to distinguish between the results of intentional formation and involuntary deformation due to the lying on hard surfaces. For these purposes I am making comparisons between subjects who have and have not undergone head shaping, and between those who have and have not suffered from a pillowless infancy. Striking examples of the latter are to be found among the small colony of Epirote bakers, who, owing to the extreme poverty of their parents at home, the circumstances of which I shall enter into more fully elsewhere, possess the most extraordinary and incredible head-shapes it has been my lot to see. Similar observations are being made upon the Armenian settlement here. Observations on these two extreme forms of head will prove instructive in comparison with the results of similar, though modified, treatment of the Cretan native. Further, whole families of Cretans are under observation, and measurements and contours have been taken of them, including children who have and have not been bandaged in their infancy, from the age of fourteen days up.

In addition to these researches which are in

progress, I have been able to garner from a cave, where are carelessly consigned the bones of many a deceased Cretan of to-day after a short burial in the cemetery, some hundred bones from all parts of the skeleton, saving, unfortunately, the cranium; and thus a comparison is possible between skeleton and skeleton of ancient and modern times. Two collections of hair, representing a series of shades, have been made for me by Orthodox and Mussulman barbers in Candia.

Crete appears to me to be a more than ordinarily instructive and significant field of research, and I hope that in the short time at my disposal I may find answers to some of the many questions which open up at every turn.

The committee to conduct archeological and ethnological investigations in Sardinia report as follows: Dr. Duncan Mackenzie, honorary student of the British School at Rome, returned to Sardinia at the end of September, 1908, and stayed there till the middle of November. He was accompanied for part of the time by the director, Dr. Thomas Ashby, and by an architectural draughtsman, Mr. F. G. Newton, student of the school.

Their new observations have materially increased our knowledge of the two main groups of Sardinian megalithic monuments, the Nuraghi and the "Tombs of the Giants." The previous year's work made it clear that the former were fortified habitations. Dr. Mackenzie has now visited other examples and recorded variations of type and peculiarities of construction. The most remarkable is the Nuraghe of Voes in the Bitti district towards the north of Central Sardinia. Triangular in plan, it contains on the ground floor circular chambers with bee-hive roofs; the usual central chamber and one in each of the three angles. The entrance is on the south and leads into a small open court with a doorway at each side leading to the chamber at the base of the triangle, and another doorway straight in front by which the central chamber is entered. There was an upper story, now destroyed, reached by a stairway of the usual type. Exceptional features are two long curving corridors in the thickness of the wall on two sides of the triangle, intended probably as places of concealment. Above them were others of similar plan, but both series are so low that the roof of the upper one is level with that of the bee-hive chamber on the ground floor. This skilfully planned stronghold must have been built all at one time; other large Nuraghi were originally of simpler design, and have grown by the addition of bastions and towers.

A new type of Nuraghe was discovered at Nossia near the modern village of Paulilatino, in Central Sardinia. It is a massive quadrangular citadel of irregular rhomboidal plan with a round tower at each corner. These towers resemble the stone huts of the villages attached to some of the Nuraghi; they are entered from a central courtyard which here takes the place of the normal bee-hive chamber. It was partly filled with circular huts, so that this Nuraghe must be regarded as a fortified village rather than as the castle of a chieftain.

The dwellers in these Nuraghi buried their dead in family sepulchers popularly known as Tombs of the Giants. Several writers had suggested that these tombs with their elongated chamber and crescent-shaped front were derived from the more ancient dolmen type, but hitherto there was little evidence to support this conjecture, only one dolmen being known in Sardinia. Dr. Mackenzie has now made this derivation certain; he has studied ten important groups of dolmen tombs, most of them entirely unknown, which furnish a series of transitional types. In one case the chamber of an original dolmen tomb had at a later period been elongated so as to resemble that of a Giant's Tomb. In another example the large covering slab was supported by upright slabs at the sides and back; and behind it there are traces of an apse-like enclosing wall, such as is characteristic both of the Giants' Tombs and also of dolmens in certain localities where Giants' Tombs do not exist; for example, in northern Corsica and in Ireland. Dr. Mackenzie also discovered a new type of Giant's Tomb in which the mound was entirely faced with stone, upright slabs being used below and polygonal work above. Another feature, hitherto unique, is a hidden entrance into the chamber at one side, in addition to the usual small hole in the center of the front through which libations and offerings were probably introduced.

These results were described at a meeting of the British School at Rome in March, 1909 (see *Athenæum* of March 27). An illustrated report of them will appear in volume V. of the *Papers* of the school.

Dr. Mackenzie and Mr. Newton intend to go to Sardinia, in September, for six weeks in order to continue the exploration of the island. The importance of anthropometrical work in connection with the problems presented by the early civilization of Sardinia was pointed out in a previous report of this committee. Mr. W. L. H. Duck-

worth, a member of the committee, went to Rome last April and studied the collection of one hundred Sardinan crania in the Collegio Romano. He made about 1,200 measurements, and is preparing a report which will serve as a basis of comparison with any collection of ancient crania that may be obtained. In addition to these specimens, which had not been described previously, Mr. Duckworth has examined about thirty Sardinian crania in the museums of Rome and Paris. He has recently spent ten days in Corsica, where he obtained valuable illustrative material, and hopes to take part in Dr. Mackenzie's expedition to Sardinia in September next.

The committee ask to be reappointed, and apply for a grant.

Although the last report of the committee on anthropometric investigation in the British Isles was considered to be final as regards the method of anthropometric investigation, it was thought advisable to reappoint the committee to act as an organizing center to promote the establishment of anthropometric investigation among all classes of the population of the British Isles. In this direction important work has been done during the past year.

In October last, the secretary, at the request of Dr. Rawson, the principal of Battersea Polytechnic, instructed his medical officer in the method of carrying out measurements in accordance with the committee's scheme.

The importance of installing anthropometry in public schools was brought under the notice of the Headmasters' Conference on February 10 last, and their cooperation was asked for. In reply, a letter, dated May 21, was received from the secretary of the Headmasters's Conference committee, suggesting the issue of a short circular explaining the items of information that it was most important to collect. In response to this suggestion a memorandum was drawn up and sent out by the anthropometric committee to the headmasters of 107 public schools. It is hoped that this action will result, in the course of time, in the general establishment of anthropometry in public schools.

Measurements are now being carried out generally under the direction of the medical officers of the education authorities, in primary schools, and in a certain number of provided secondary schools. But there is still a wide field among secondary schools for both boys and girls in which the committee could do good work.

The 1908 report of the committee on anthropometric method has been issued as a separate publication by the Royal Anthropological Institute (price, 1s. net). This will make the scheme of the committee available, in cheap and convenient form, to all who propose to undertake anthropometric work, and will ensure the uniformity which is so essential to make the results of different measurers comparable.

The committee recommend that they should be reappointed, with a grant of £5 for printing or typing circulars, postage, stationery, etc.

The work of the committee on the establishment of a system of measuring mental characters is going forward and promises to yield interesting results, but is not sufficiently advanced for a full report.

The committee ask to be reappointed, and that a grant of £5 be made to them for printing cards and other inevitable expenses.

President Myres reported for the committee to investigate neolithic sites in northern Greece. The work has been done by the Liverpool Archeological Institute. The mounds of southern Thessaly are found to be the accumulations of successive village sites. This region was occupied by a neolithic population that formed an effective barrier between the Mediterranean civilization on the south and that of the Danube valley on the north, and lagged behind both. At the top of one of these mounds were found bronze age graves of an Ægean people. Only a few mounds have as yet been opened, while hundreds remain untouched.

The papers presented covered a wide range of subjects. A majority of these are given in abstract.

Miss A. C. Breton described "Race Types in the Ancient Sculptures and Paintings of Mexico and Central America." The different race types in the ancient sculptures and paintings found in Mexico and Central America form an important anthropological study. An enormous mass of material, evidently of many periods, includes sculpture, archaic stone statuettes, the portrait statues and reliefs at Chichen Itza, the Palenque reliefs and the series of magnificent stelæ and lintels at Piedras Negras, Yaxchilan, Naranjo, Copan, Quirigua, etc.

In terra cotta or clay there are the hundreds of thousands of small portrait heads and figurines found at Teotihuacan, Otumba, the neighborhood of Toluca and other ancient sites. Larger clay figures have been found in quantities in tombs, as in the states of Jalisco and Oaxaca; these were made as offerings, instead of the sacrifice at a

chief's burial of his wives and servants. Small jadeite heads and figures, also found in tombs, show strongly marked types. If there are few specimens in gold, it is because throughout the country the Spaniards ransacked the tombs for gold. In painting there are the picture manuscripts, the fescoes at Chichen Itza, Chacmultun and Teotihuacan and a number of vases with figures from Guatemala and British Honduras.

This material is now available for students in Mr. A. Maudslay's "Biologia Centrali-Americana, Archeology," Dr. E. Seler's collected works, the publications of the Peabody Museum, and the reproductions of the Codices by the Duc de Loubat, also in the splendid collections of the Museum für Völkerkunde at Berlin, the Mexican Hall of the Natural History Museum at New York and the Peabody Museum.

Among distinctive types are: the chiefs in the reliefs at Xochicales, who sit cross-legged; the little shaven clay heads at Teotihuacan; the tall, well-built priests, with protruding lower lip, of the Palenque reliefs; the fifteen caryatid statues in feather mantles, of the Upper Temple of the Tigers, at Chichen Itza; and the sixteen stern warriors carved at its doors, these last similar in type to some of the modern Indians of the villages near Tlaxcala.

There are portraits of the Mexican kings on the border of a picture-map which represents the western quarter of Tenochtitlan, and of the householders in that part of the city. Of female types there are the painted clay figures of Jalises with compressed heads. Some of them have short, broad figures, others are slender. Both types still survive. The queenly women in Codex Nuttall-Zouche, and the women-chiefs of the Guatemalan stelæ belonged to a different caste to the obviously inferior women on those stelæ, fattened in preparation for sacrifice.

Herr T. Maler's most recent explorations on the borders of Guatemala have given magnificent results in the finding of thirty-seven stelæ at Piedras Negras, and at Yaxchilan twenty stelæ and forty-six sculptured lintels. The superb figures of warriors and priests indicate a race of men of tall, slender stature and oval face, with large aquiline nose, whilst the captives appear to be of a different race.

A second paper by Miss Breton dealt with the "Arms and Accoutrements of the Ancient Warriors at Chichen Itza." Chichen Itza, in Yucatan, is as yet the principal place in the region of Mexico and Central America where representatives of armed warriors are found. There was a remarkable development in the later history of the buildings there of painted sculptures and wall-paintings, mostly of battle scenes and gatherings of armed chiefs.

The stone walls of the ruined lower hall of the Temple of the Tigers are covered with sculptured rows of chiefs, who carry a variety of weapons. Of the sixty-four personages left, half a dozen have ground or polished stone implements; others hold formidable harpoons (two of them double) or lances adorned with feathers; whilst the majority have from three to five spears and an atlatl (*i. e.*, throwing stick). These are of different shapes. One figure has armlets with projecting rounded stones. Some have kilts, sporrans, leggings and sandals. Eleven personages have tail appendages. There are protective sleeves in a series of puffs, breastplates, helmets and feather head-dresses, necklaces of stone beads, masks, ear and nose ornaments in variety. Small round back-shields, always painted green and fastened on by a broad red belt, may have been of bronze attached to leather, as a bronze disc has been found. Round or oblong shields were carried by two thongs, one held in the left hand, the other slipped over the arm.

The two upper chambers of the same building have reliefs on the door jambs of sixteen warriors life size. They carry a sort of boomerang in addition to spears and atlatls. In the outer chamber was a great stone table or altar, supported by fifteen caryatid figures. Upon its surface was a relief of a standing chief, holding out his atlatl over a kneeling enemy who offers a weapon. The walls of both chambers were covered with painted battle scenes, in which several hundred figures are still visible. They carry spears, atlatls, round or oblong shields, and a kind of boomerang which was used by the natives in Australia about eighty years ago. It was intended for striking rather than throwing. On one wall the method of attacking high places by means of long notched tree-trunks as ladders and scaffold towers is shown.

The building at the north end of the great Ball Court is evidently very ancient, and its sculptured walls have chiefs with spears and atlatls. The temple on the great pyramid called the Castillo also has warriors on its doorposts and pillars, with boomerangs, spears and atlatls, and so has a building in the great Square of Columns. In an upper chamber of the palace of the Monjes are paintings in which are men with spears and atlatls, and also spears with lighted grass at-

tached thrown against high-roofed buildings. A survey of all that has so far been discovered at Chichen gives a vivid idea of primitive battle array.

One whole day was devoted to papers and discussion relating to a proposed ethnographical survey of Canada. Mr. E. Sidney Hartland began with a "Retrospect" which told of the state of culture encountered by the French when they took possession of the territory in the seventeenth century and which reviewed the work that has been carried on since then by men as well as institutions.

Professor Franz Boas, whose investigations in the Canadian field of anthropology are of the first importance, summed up the "Ethnological Problems of Canada." In the past twenty years a general reconnaissance has been made largely through the influence and financial aid of the British Association. The time has come to concentrate attention on specific regions and problems. Many of the general problems embrace the whole of the western hemisphere, such, for example, as the wide distribution of Indian corn and the angular character of the art. The culture of the American Indians is remarkably uniform in comparison to that of Africa or Australia. The continent may be divided into a central, marginal, isthmian and an island region. The Canadian aborigines belong to the northern marginal culture. The origin of the Iroquois is placed in the southern Appalachian Mountains, although at the time of the discovery they occupied the lower St. Lawrence. The Iroquoian language has nothing in common with Algonquian, Siouian or Eskimo. On the other hand, it resembles the Pawnee and the tribes of the southwest. The blow gun of the Iroquois seems to connect them with the peoples of the Gulf of Mexico and of South America. The Iroquois, therefore, do not belong to the northern marginal culture. The Cree (Algonquin) of Labrador have migrated as far west as Kamloops, B. C., and isolated Athabascan tribes are found along the Pacific coast. Lack of intensity of the Athapascan culture accounts for the readiness with which it is influenced by contact with neighboring cultures. The Alaskan Eskimo came in recent times from northeastern America instead of from Asia, as was formerly believed. On the other hand, that there has been close contact between Siberia and northwestern America is suggested by house forms and in other ways. One of the problems is to trace the northwestern limit of the use of pottery.

An "Ethnographic Study of the White Settlers" was discussed by Dr. F. C. Shrubsall, who spoke of what was being done to improve the breeds of live stock and the varieties of grain in contrast with the lack of interest shown in the improvement of the human race. The speaker urged upon the government the importance of taking preventive measures while the dominion was still young as a means of avoiding the necessity of remedial measures which confront the peoples of the old world.

Dr. G. B. Gordon contributed two papers on American anthropology. The first of these was a review of the researches into the history of man on the North American continent that have been carried on under the auspices of the government and institutions of the United States. He called attention to certain far-reaching changes that have been witnessed in the attitude of the educated classes and especially of the institutions of learning with reference to those studies that fall directly within the province of anthropology, changes which it is believed are destined to affect very profoundly those interrelated branches of learning, which, like history and sociology, are most directly affected by the anthropological method. These tendencies are made manifest by the history of anthropological activities in those quarters that are most influential in shaping educational development and methods of research.

The work of the Smithsonian Institution through the Bureau of Ethnology has been a prominent factor in promoting that interest in the study of the native races which has been carried on with successful results by the great universities and museums of the country. Nothing in the history of anthropology is more significant than the present condition of archeological studies in the great universities as contrasted with that which obtained a few years ago. Until very recently the name of American archeology was obnoxious because it was foreign to European civilization. To-day in the same quarters the chief archeological interest lies in the prehistoric period; and with a realization of the unity of all problems of human development comes a rapidly increasing interest in American archeology as a subject of study. This is the condition of archeological science in American institutions of learning to-day; and as an index of this condition the Archeological Institute of America, which for many years has maintained schools at Athens, Rome and Jerusalem has only last year established a similar school in New Mexico and is

making an effort to establish another in the City of Mexico, the object of these two schools being the study of American archeology.

After reviewing the work done by Harvard, Yale, Columbia, the University of California, the University of Pennsylvania, the American Museum of Natural History and the Field Museum of Natural History, Dr. Gordon called attention to the services rendered to anthropology by private individuals and paid a special tribute to Mr. George G. Heye, of New York, whose collections of American archeology and ethnology assembled during the last two years may be compared in magnitude and importance with those assembled during the same period by some of the larger museums. The result achieved in this instance may serve to indicate what may be done in American archeology in a short time by one man who is possessed not only of the necessary means, but also the necessary energy intelligently directed. These splendid collections are now being installed in the University of Pennsylvania Museum, where Mr. Heye has been elected chairman for American anthropology on the board of managers in recognition of his conspicuous services to science.

In similar terms the speaker referred to the archeological work done by Mr. B. Talbot B. Hyde among the ruined pueblos, where a splendid collection of pottery and other art objects was obtained, which has been divided between the American Museum of Natural History in New York and the University Museum in Philadelphia.

Dr. Gordon's second contribution was based on his "Ethnological Researches in Alaska." In 1907 he made an expedition on behalf of the University of Pennsylvania Museum into the Koskokwim Valley in Alaska to investigate the natives of that region, who, owing to the remoteness of their habitat from the white man's influence, preserve in a marked degree their aboriginal characteristics. The route followed was from Dawson westward by way of the Tanana and Kantishna rivers to the headwaters of the Koskokwim, thence down the entire length of that river to the coast. In the upper valley of the Koskokwim were found Dené tribes preserving the characteristics of the wide-spread Dené stock. About seven hundred miles from the mouth of the river, Eskimo influence began to be felt; two or three hundred miles farther down Eskimo customs had entirely replaced the native customs even in those communities where there was little or no mixture of Eskimo blood. The tendency of the Dené in this region to adopt Eskimo culture which has intruded from the Behring Sea coast is strongly marked and shows that the Eskimo culture is the more aggressive and the more advanced. At the mouth of the Koskokwim, the Eskimo communities have retained in full vigor their peculiar customs and mode of life, because that part of the Alaskan coast has not been visited by trading vessels or by whalers.

The general health and physical welfare of these communities as well as of those on the Koskokwin River were noticeably better than in those localities where the natives have been in continued contact with the white man's influence, as, for instance, on the Yukon and on Norton Sound. At the same time the mental and moral state of the former population is decidedly better than that of the latter. All observations tended to show that the inhabitants of Alaska, both Dené and Eskimo, undergo deterioration physical and moral under the influence of civilization.

Mr. Charles Hill-Tout gave an account of his researches into the "Ethnology of the Okanâkēn," the easternmost division of the Salish of British Columbia. The subject was treated from the standpoint of habitat and old settlements, relation of the common language spoken by the whole division to contiguous linguistic divisions of the same stock, material and social culture, totemism, evidence from material culture and language bearing upon the origin of the stock before the division into its present grouping. The linguistic evidence points to a connection with Oceanic stocks. Specimens of Okanâkēn myths were given, also an outline of the grammatical structure of the Okanâkēn dialect.

Professor E. Guthrie Perry exhibited an interesting series of copper implements recently found together in the bed of the river at Fort Francis, Ontario. The fact that one of the pieces is tipped with silver leads Professor Perry to conclude that the material from which these implements were made came from the north shore of Lake Superior.

Another communication of special local interest was that by Professor Henry Montgomery on the "Archeology of Ontario and Manitoba."

Much of the seventeenth century's history of that portion of Canada now known as Ontario has been verified, and additional information obtained about the Iroquois, Hurons and Algonquins and also the earlier inhabitants by the archeologists Tache, Daniel Wilson, A. F. Hunter and David Boyle. Some of the collections are in the Toronto Provincial University, others in the Toronto Provincial Normal School, the Dominion Survey Mu-

seum in Ottawa and Laval University, Quebec. There have been several occupations of the province. The following are the principal kinds of remains found: marine and fresh-water shell objects, bone awls and knives, arrow points, stone knives and scrapers, stone wedges and chisels, stone gouges, stone pipes, gorgets or banner stones (generally made of Huronian slate), amulets (or perhaps ceremonial stones), pipes of pottery of many patterns, as well as vessels of pottery, the last being mostly broken. Mention was made of a large amulet or ceremonial stone nineteen inches in length, and made of limestone, which was recently found beneath the stump of a large oak tree the cross-section of which had two hundred and eighty rings of growth. The wedges, chisels and gouges are of good form and finish, and are plentiful. All these objects of manufacture have been found on or near the surface of the ground.

Ossuaries or circular bone-pits fifteen to twenty feet in diameter and six to eight feet in depth have been discovered near Georgian Bay and in a few counties bordering upon Lake Ontario. The writer of the paper referred to his work in these ossuaries in 1876 and 1878 in Durham and Simcoe counties. Articles of French manufacture occurred in some of them, and the crania in all of them are of the Huron form. Some ancient skulls found in other parts of Ontario were described as being of a very inferior type, the frontal portion being extremely low and narrow, and the supernumerary bones numerous.

Primitive paintings may be seen on the faces of rocks along the shores of a few of the northern lakes. It is not known by what people they were made.

There are aboriginal tumuli in southeastern Ontario and also in the vicinity of the Lake of the Woods and Rainy River. Already some interesting things have been obtained from them in the way of pottery vessels and of copper and stone implements and ornaments. Large oak trees grow upon some of these mounds. One long mound in eastern Ontario has been described as a "serpent" mound; but, the writer by a personal examination of this mound has not found satisfactory evidence that it was intended to represent a serpent. It bears very little resemblance to the famous serpent mound of Ohio. It is, however, undoubtedly artificial, and it shows a relationship with certain mounds of the province of Manitoba.

The archeological remains in Manitoba may be regarded as belonging to two classes, namely, those objects, such as grooved stone mauls and hammers, stone discs, arrow points and broken pottery, found upon or near the surface of the ground, and, secondly, tumuli, earthen ridges and house enclosures. The tumuli of earth are sometimes of considerable size, and often have human skeletons with vessels of earthenware and implements and ornaments of bone, shell, stone, antler and copper buried within them. The specimens obtained from these mounds are usually few in number. But they are very characteristic and instructive in Manitoba and vicinity. Long, wide ridges of earth occur in this province, the largest found being about 2,000 feet long, forty feet wide and three feet high. Of the many examined by the writer one such ridge in Dakota measured 2,688 feet in length. It is probable that these earth ridges were used for ceremonial purposes.

Two kinds of burial mounds occur, and also mounds which were used as house-sites, only objects which were of domestic use having been found in the latter. A burial mound, which the writer explored last year, has a definite structure of considerable interest. A burial pit, three feet and six inches in diameter and two feet deep, was found a little southeast of its center. The pit contained five human skeletons, one large earthen pipe decorated by a groove around its bowl and transverse grooves in the lower side of its horizontal stem. Its bowl was 2¼ inches across and 3¼ inches high. There were also with the pipe and skeletons a barbed flint arrow point, marine shell (two species) beads, one polished round stone the size of a very large marble, and a valve of the river shell Unio containing some red ochre. The burial pit extended through the soil and down into the subsoil. Around the pit and forming a circular area of about twelve feet in diameter the soil consisted of a purplish solidified mass. Upon this and extending over the pit was a calcareous layer from three to six inches in thickness and about twelve feet in diameter. There were two large stone boulders above the calcareous layer, and all were covered with the rich black prairie soil. Within this black soil, and about two feet above the calcareous layer, was a layer of yellow clay from four to six inches thick and about equal in extent to that of the calcareous layer covering the pit below. Usually in these mounds there is a variety of objects, shell pendants and necklaces, spoons, beads, bone armlets, stone pipes and pottery vessels. The two most characteristic objects buried with the human remains are small pottery urns of coiled ware decorated externally by a spiral furrow, and the straight, tubular, catlinite

stone pipes. The marine shell beads and the Michigan native copper objects are also somewhat characteristic. In addition to the three classes of tumuli and the ridges there are communal house-sites or large enclosures. The largest measured by the writer was eighty feet wide and two hundred and twenty-five feet long. The wall of this enclosure is now about ten feet thick and eighteen inches high. There are many cromlechs or stone-circles in Saskatchewan, and probably some occur in Manitoba. Possibly the extinct Arikaras of Dakota were related to the builders of the more ancient of the burial mounds in this region. A copper wedge, a sheet of native silver and copper, an amulet and other specimens from Ontario, as well as many photographs and drawings of Manitoba mound products, were exhibited to the members of the association.

In "The Blackfoot Medical Priesthood," Dr. John MacLean defined medicine men, or, to use a better term, the medical priesthood, as shamans, conjurers, doctors, prophets and priests, and gave the different grades in the priesthood. The subject of initiation was dealt with, and the course of instruction was outlined. Previous to this the would-be medicine man undergoes a period of voluntary seclusion, during which he fasts and sees visions. The dress and facial decoration of the fraternity was described, and the sacred numbers were explained. The subject of disease was next treated, the Blackfeet being particularly prone to small-pox and consumption. The causes of the diseases were discussed, especially the influence which the belief in evil spirits has upon the minds and bodies of the natives. The author then treated of the medicine man in connection with religion, such subjects as animism, sacred stones, sacrifice, spiritualism, hypnotism, prophecy and incantation being discussed, as well as medicine songs, charms and amulets. Lastly, the author considered native medicines and remedies, and discussed the value of the work of the medicine men among the natives, and the influence exercised by them on the native religion.

The western hemisphere did not by any means monopolize the attention of the section. In addition to the reports of standing committees already noted, a number of papers were presented and on a variety of subjects. Mr. D. G. Hogarth sent a paper giving the results of "Recent Hittite Research," which confirm the theory that the original home of the Hittites was Cappadocia. The city of Boghaz Kai was the center of the confederacy and contained the royal archives of the Hittite kings from the fifteenth to the twelfth centuries B.C.

Dr. T. Ashby presented a communication on "Prehistoric Antiquities in Malta." Excavations have been conducted by the government of Malta on the Corradino Hill, in which the cooperation of the British School at Rome has been cordially welcomed, and its investigations assisted in every way; the supervision has been entrusted to the director of the school and to Mr. T. E. Peet, student of the school, assisted by the constant cooperation of Dr. T. Zammit, curator of the museum. The great megalithic buildings of Gigantia, Mnaidra and Hağar-Kim, which Dr. Arthur Evans considers to have been buildings of a sepulchral character in which a cult of departed heroes gradually grew up, and other smaller prehistoric monuments of the islands, have been carefully described by Dr. Albert Mayr, though others have since become known, but excavation was needed in order that many essential facts might be ascertained. The investigation of the rock-cut hypogeum of Halsaflieni, the architectural features of which imitate in the most surprising way those of the sanctuaries above ground, has for the first time produced an adequate series, available for study, of the prehistoric pottery of Malta; for from the excavations of Hağar-Kim but little has been, unfortunately, preserved. Dr. Zammit and Professor Tagliaferro will shortly publish adequate descriptions of the hypogeum and its contents. Of the three groups of megalithic buildings on the Corradino Hill, two had been already in great part excavated in the nineties, and the complete clearing of the upper one, which apparently was of a domestic character, was the first work undertaken in May. Its plan is extremely irregular, and much of it can hardly have been roofed unless in thatch or woodwork. A considerable quantity of pottery was found, very similar in character to that of Halsaflieni, and belonging, like it, to the late neolithic period. It has some affinities with pottery recently found in Terranova, the ancient Gela, in Sicily, but in many respects is unique. Many flints were found, but no traces of metal. A stone pillar was found in one portion of the building, some two feet eight inches long and about ten inches in diameter, which may have been an object of worship. The excavation of a second and smaller group, nearer the harbor, had been already completed by Dr. Zammit and Professor Tagliaferro; but a third, further to the south, on the summit of the ridge, had never been examined, and it, too, was thoroughly investigated. An even larger quantity of

pottery of the same character was found, with flints and fragments of stone basins, etc. It approximates more in style to the larger megalithic buildings of the island, and has a facade with a more pronounced curve than at Hağar-Kim, constructed of very large blocks, but much ruined. The interior consists of several distinct groups of rooms (often apsidal) not intercommunicating. The construction is of rough masonry, with large slabs at the bottom, and smaller blocks higher up; the walls begin to converge, even at the height (5 to 6 feet) to which they are preserved, as though to form a roof. Into one of the rooms a very curious trough has at a later period been inserted; it is cut in a block of the local hard stone, eight feet nine inches long, three feet eight inches wide, and is divided by six transverse divisions into seven small compartments, which show much trace of wear. The object of it is not as yet apparent. Another more carefully constructed room, perhaps contemporary with the trough, has its walls partly of large slabs, partly of narrow pillar-like stones. The floors of these rooms are sometimes of cement, sometimes of slabs. Many bones of animals were found, but only one human skeleton, and that in disorder and at a comparatively high level. The use of standing slabs at the base of walls, with coursed masonry above, visible in these buildings, finds its parallel in the Giants' Tombs at Sardinia, the prehistoric huts of Lampedusa, and in many other places.

Dr. F. C. Shrubsall spoke on "The Influence of Geographical Factors on the Distribution of Racial Types in Africa." The movement seems to have been from north to south, following the course of the mountain ranges and across the continent eastward and westward following the great river systems. The influence of the nature and configuration of the land and of climatic conditions upon the natives was explained. The presence in certain regions of the tsetse fly and other parasitic pests led to modified conditions in the animal life and thus directly or indirectly influenced the occupation of these sections by the native races.

"A Study of Malaria in Ancient Italy," by Mr. W. H. S. Jones, was read by Dr. Shrubsall in the absence of the author. Malaria has exerted a powerful but unmeasured influence on the history of Rome. It is caused by a mosquito. The patient becomes immune only after many years. In order to escape from the mosquito, which can not fly far, towns were built on the hills. At a very early period Rome was marshy. Whether it was malarious before 500 B.C. is an open question, although the disease is thought to have been introduced by merchants from Africa as early as 600 or 700 B.C. Continuous wars brought about conditions that tended to increase the breeding of mosquitoes and thereby the prevalence of malaria. The periodicity of the fever gave rise to the belief that it was a divine visitation. There was thus a goddess of fever. The author cited early writers who mention fever.

A communication describing "A Cult of Executed Criminals in Sicily" was presented by Mr. E. Sidney Hartland. Certain of the Sicilian peasantry believe in the intercessory powers of beheaded malefactors, or "Decollati," to whom petitions are addressed. Instances ranging from the prayers of the love-lorn maiden to appeals for protection in times of attack by robbers were cited by the author. Dr. D. Randall-MacIver's paper on "A Nubian Cemetery at Anibeh" was read by Professor Gordon, and that of Mr. F. M. Dawkins on "The Excavations at Sparta of the British School at Athens," by Professor Myres.

Many social functions were held in connection with the week's program at Winnipeg, among them being receptions by Lord and Lady Strathcona, the Lieutenant-Governor and Lady McMillan, Mr. C. C. Chipman, commissioner of the Hudson's Bay Company for North America, and Mrs. Chipman, Chief Justice and Mrs. Howell, Principal and Mrs. W. J. Black, and the local executive committee. Excursions were also made to many points of interest in and about Winnipeg.

At the close of the meeting about 180 members, including the officers and guests of the association, were invited to take part in an excursion from Winnipeg to the Pacific coast and back. This was made possible through the generosity of the western provinces. The schedule was planned so as to include visits to the capitals and largest cities of the provinces as well as mountain resorts like Banff, Lake Louise and Glacier. The stop at Gleichen afforded an opportunity to see a group of Blackfeet Indians. The scientists highly appreciate and will long remember the courtesies extended by the reception committees at Regina, Moose Jaw, Calgary, Vancouver, Victoria and Edmonton. They were also much impressed by the rapid material development of the country and its splendid endowment of as yet unmeasured resources.

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Yale University,
New Haven, Conn.

SCIENCE

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THE QUANTITATIVE STUDY OF ORGANIC REACTIONS[1]

BEFORE this body of chemists it is not necessary to call attention to the importance of many of the great researches in the field of so-called pure organic chemistry. The investigations of Liebig and Woehler and Fischer on uric acid derivatives, of Friedel and Kraft and others on the use of aluminium chloride, ferric chloride and zinc chloride in effecting many condensations; of Sandmeyer and Gatterman, Hantzsch, and Bamberger on the formation of diazo compounds and their derivatives; of Baeyer, Greene, Nietzki, Fischer and others on the formation of dyes; of Willstaetter, Pictet, Koenigs, and Pschorr on the alkaloids; of Wallach, Tiemann, Semmler and Harries on the terpenes; of Fischer, Kiliani, Tollens, Bruyn, Wohl and Ruff on the sugars, and of Fischer, Abderhalden, Neuberg, Curtius, Kossel, Osborne and Chittenden on the proteid compounds—all of these great researches speak for themselves in their importance to pure science, technology, medicine and the biological branches.

However much the physical chemist may turn up his nose, or hold it, in the organic laboratory and call us *pot-boilers* and *stink-producers* and *mere compound-makers;* however much the clean-working analytical or inorganic chemist may rail at us because we do not, as a rule, collect and weigh our organic precipitates accurately to within 0.10 per cent., yet these same deluded col-

[1] Address of the chairman of the Division of Organic Chemistry in Section C of the American Association for the Advancement of Science, Baltimore, 1908.

leagues seize eagerly upon our organic solvents for use in their inaccurate methods for the determination of molecular weights, and upon our organic indicators to aid them in poor analyses. They clamor for, and would die without, our medicines, such as whiskey (*imitation* or any kind), atropine, quinine and ether, our cane sugar and glucose and our artificial breakfast foods; and their dainty daughters could not so entrancingly lure sweethearts without our beautiful dyes in their silks and cheeks, our delightful synthetic violet perfume in their handkerchiefs and our artificial pineapple, strawberry and vanilla in their dangerous embryonic pastries and ices. This same compound-making, this so-called *old style* organic chemistry, with its reactions and methods, is not only of the very greatest importance to science and economy, but is becoming more so every day.

But we have another side to organic chemistry, which appeals to the physical and inorganic chemists, and so much so, indeed, that they try to appropriate it in their text-books as part of their own domain: namely, the quantitative study of organic reactions. In pointing out the problems that busy our organic chemists, perhaps I can not do better than to bring to your attention some of the researches that have been, or are being, completed and still other problems whose solution is of the greatest importance to the chemical world.

The question of fundamental importance in any reaction, and the one that must be answered first, is: *What are the constituents that are really uniting or reacting to give the end products?* When this is known *we must then determine quantitatively the natural constants which govern the concentrations of the reacting constituents at any time and their velocity of transformation and final equilibrium.* These constants are just as characteristic as are the melting points and molecular weights for each set of substances under definite conditions, that is, in definite concentrations, in definite solvents, at definite temperatures and exposed to definite wavelengths of light of given intensity, etc.

The question as to what are the really active constituents of a given reacting mixture, whether it be one of organic or inorganic substances, is not always easily answered. Do the molecules which we put together unite or do their simple or complex ions enter into combination? Some of our prominent physical chemists tell us "that most chemical reactions, if not all, are reactions between ions; molecules, as such, do not enter into the reaction at all." On the other hand, other prominent physical chemists go perhaps too far in the other direction: they elect their colleagues with brotherly love to life membership and exalted rank in their own Ananias Club and declare that "whoever claims that the instantaneous chemical changes in aqueous, or other, conducting solutions take place because of the fact that these solutions are electrolytes (or in current phraseology, because they contain ions), must assume the burden of proving his proposition," a statement to which we must all agree. Both of these factions of physical chemists, I believe, fail to weigh judicially all of the experimental evidence at hand. The champions of the union of ions as the cause of chemical reactions argued from such facts as the failure of dry hydrochloric acid and dry ammonia to form ammonium chloride. We can challenge them to prove beyond question (1) that the molecules do not react in the presence of moisture, (2) that the gases were perfectly dry, (3) that the gases did not actually slowly unite. They could answer that no *apparent* union took place in a great length of time: but we could

recall to them that neither do dry hydrogen and oxygen *apparently* unite at ordinary temperatures, even in the presence of platinum. Yet Bodenstein has proved that they *do* unite appreciably at temperatures above 500° C. in the presence of platinum, and he has calculated that if the observed temperature coefficients hold it would require the volumes of hydrogen and oxygen with which he worked ***several hundred years to form a small fraction of a milligram of water at ordinary temperatures.*** We sincerely hope that our ardent admirers of ions will start these experiments for their posterity to finish as a monument to them. On the other hand, the defender of the divine right of molecules to enter into instantaneous chemical reactions ignored the small minority of the ions present with the large number of molecules in such mixtures as hydrochloric acid and copper oleate in benzene solution. It does not follow that because such solutions hardly conduct the electric current there may not be present, in practically instantaneous equilibrium with the molecules, *minimal amounts of ions which react with each other with enormously high velocities.*

This point is perhaps best illustrated by the beautiful work of Whitney, Melcher, Kuester, Bodlaender and others, on solutions of the complex cyanides and ammonium compounds of copper, cadmium and silver, in which only minimal traces of the silver, copper and cadmium ions exist. A normal solution of $KAg(CN)_2$ contains so few silver ions that the dissociation constant,

$$K=\frac{Ag(CN)_2}{Ag\times(CN)^2},$$

has the enormously high value 10^{23}, which expresses in liters the volume of water which flows over the Niagara Falls in *500,000,000 years!* Yet the silver can be electrolyzed out of this same solution in a very short time. The dissociation constant of the complex cadmium cyanide ion,

$$K=\frac{Cd(CN)_4}{Cd\times(CN)^4},$$

is 10^{17} and that of hydrogen sulphide,

$$\frac{H_2S}{H\times SH}=K,$$

is 1.75×10^7, and yet in a mixture of solutions of these two substances the cadmium sulphide is precipitated almost instantaneously. Indeed it seems possible that ions with the mass which we are accustomed to ascribe to them must be so far apart in such solutions that they can not possibly migrate rapidly enough to allow all of them to come together in such a short time, and it may be that further investigation will show that these complex cyanides and ammonium compounds react in some cases through their complex ions or molecules. Kahlenberg has done great service to physical chemistry by insisting that some reactions may be those of molecules. It is quite evident then that in such inorganic reactions, which usually take place with very high velocities, it is sometimes very difficult to decide whether the constituents directly concerned are molecules or ions.

But organic chemistry offers us a rich field in which all kinds of reactions can be found. Most of these take place comparatively slowly and can be studied easily, and the values of the various constants can be determined accurately. In some reactions we have already shown that both ions and molecules undergo transformation. Of course many organic reactions do not lend themselves to quantitative work, on account of complex or disturbing side reactions which can not be followed accurately, or on account of the difficulty of finding a good analytical method for determining the concentration of each constituent at any moment. But it is certain that we could not have had the best development of the law

of mass-action, of reactions of the first and second order, of the development of temperature coefficients, of Thomson's study of energy changes in combustion, etc., without the quantitative study of such organic reactions as the inversion of cane sugar, hydrolysis of methyl acetate, etc.

It will, perhaps, not be uninteresting to discuss some of the problems that are at present occupying the attention of organic chemists. The phenomena exhibited by the so-called *tautomeric compounds* are of great importance in a large number of substances, such as quinazolines, cyanides, sulphites, cyanates, amides, acetoacetic ester, pyrazolones, uric-acid derivatives, pyrimidines, all kinds of dyestuffs, such as the rosanilines, phenolphthaleins, fluoresceins, etc. In 1899 we had several theories of the action of tautomeric compounds with other substances like alkyl halides and acid chlorides. Those of Nef, Michael, Wheeler, Comstock, Knorr and Wislicenus deserve special mention.

Comstock assumed that the potassium salt of an amide, for example, and an alkyl halide yield only one ester, the N-ester, because the potassium salt is the N-K salt (see the graphic scheme below!) and that the silver salt is an O-Ag salt and yields the O-ester. Wheeler assumed that all salts of amides are O-salts and that these salts yield the O-ester primarily, which then rearranges *per se,* or is transformed catalytically by the alkyl halides into the N-ester. Nef and Michael assumed that all salts are O-salts and that the O-ester is formed by a direct replacement of the metal, while the N-ester is formed by the primary addition of the alkyl halide to the N, or to the double bond between the N and the C. Wislicenus and Knorr believed that isomeric esters are formed by the action of alkyl halides on such so-called tautomeric salts because there are present in the molecule or ion of the salt oscillating free bonds or valences which can bind the entering alkyl group at different positions. This point of view has been used brilliantly in recent years by Lapworth.

All of these theories had much to recommend them, and each one harmonized with most of the qualitative facts known at that time. Another point of view, however, seemed to the speaker more plausible, namely, that in some cases isomeric stable esters are formed by the action of the alkylating agent on two or more tautomeric salts in equilibrium, in other cases the esters undergo rearrangement, and in other cases the anions (perhaps the molecules, too) add the alkyl halide at two different places.

Now obviously a large amount of quantitative work was an absolute necessity if we were to decide which of the above several theories is right. It was seen, too, that the chemists who undertook to solve the problem would have to work for *years* on the quantitative side before they could tell their colleagues the mechanism of these tautomeric reactions.

It may be stated that quantitative work in this particular field is very expensive, difficult and tedious, many operations being necessary to give us one set of data. If we had not been assisted so generously by the Carnegie Institution of Washington we should have made very, very slow progress. The investigations of the speaker and of Messrs. Laist, Willcox and McRae, of the University of Utah, and of Drs. Brunel, Johnson, Rogers, Shadinger and Nirdlinger, of this laboratory, during the past nine years, on the urazoles has at last brought us to the conclusion that our theory of tautomeric salts is at present the best working hypothesis for the explanation and further study of such reactions. This theory has been stated[2] as follows:

[2] For references see *Berichte der deutschen chemischen Gesellschaft,* **41**, 3199.

The weakly acid tautomeric amides, acetoacetic ester, etc., react, as a rule, only very slowly with alkyl halides, acid chlorides, etc., at ordinary temperatures, because these weak acids furnish few *anions* of the tautomeric forms to react with the alkyl halides. The addition of bases such as pyridine, alkalies or other metallic hydroxides, or sodium ethylate, causes an *increase* in the reaction velocity, or a *catalysis,* because the base forms, to a greater or lesser extent depending upon the strength of the acid or base, tautomeric salts of the amide, acetoacetic ester, etc. These salts, because they are more highly ionized than the acid, furnish the solution with a greater concentration of the *anions* of the two or more tautomeric forms, and hence the reaction velocity is increased. This acceleration is exactly analogous to the catalysis of amides, oximes, esters and cane sugar by acids in water, in which, according to the theory developed by Kastle, Bredig, Lapworth, Acree, Goldschmidt, Stieglitz and Euler, the *cations* of these substances are hydrolyzed. The free bases (amides, oximes, etc.) are so weak that they furnish only a few *cations* ($CH_3CO\overset{+}{N}H_3 + \bar{O}H$, etc.). But when acids are added these weak bases unite with them and form salts to a greater or less extent. These salts are highly ionized and hence furnish the solution with a much greater concentration of *cations,* and the reaction is accelerated merely on account of this greater concentration of *cations.*

This theory has enabled us to predict mathematically and prove experimentally the following propositions:

1. The old equations used by Ostwald and modified by Hantzsch and Stieglitz, to express the dissociation constants of such tautomeric acids and salts, especially in the phenolphthalein series, were wrong because these workers embodied in them only the ionization of one of the tautomeric forms; our point of view led us to equations for these dissociation constants which are acknowledged by the other workers to be correct and which have been tested experimentally by our own work and that of Wegscheider.

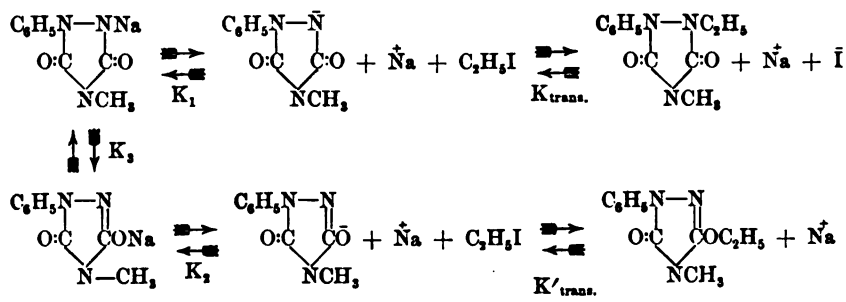
2. Our point of view on tautomeric compounds led us to a correct interpretation of the phenomena of abnormal hydrolysis which we have tested experimentally by reaction velocity methods.

3. The alkyl halide reacts with the anions and not appreciably with the molecular form of the salt.

4. The equilibrium is between the molecular forms of the salts and not between the anions as assumed by Knorr, Lapworth, Nef, Wislicenus and others. In this case, then, we have a reaction of molecules, and not of anions.

5. Our theory enabled us to predict and verify quantitatively, experimentally, the following important facts in the formation of isomeric esters from various salts of urazoles and different alkyl halides:

(*a*) Different salts and the same alkyl



halide give different ratios of N-ester to O-ester and react with different velocities because the various salts have different values for K_1, K_2 and K_3.

(*b*) The value of K_3 is not changed appreciably by a change in temperature and therefore the ratio of N-ester to O-ester is not changed. But the values of K_1 and K_2, on the one hand, and of $K_{trans.}$ and $K'_{trans.}$, on the other hand, are altered practically alike and hence the velocities of formation of both N-ester and O-ester have about the same temperature coefficients as other similar reactions.

(*c*) A change in solvent may cause a change in K_1, K_2 and K_3, and hence cause a change in the ratio of N-ester to O-ester.

(*d*) The same salt and different alkyl halides yield different ratios of esters, because $K_{trans.}$ and $K'_{trans.}$ differ for the different alkyl halides (see *g*).

(*e*) A change in the concentration of the salt and the alkyl halide does not appreciably change the ratio of the N-ester to the O-ester because there is no appreciable change in the ratio of the ions from the two salts.

(*f*) The addition of another salt with the same cation produces no appreciable change in the ratio of the N-ester to the O-ester obtained from a given salt and an alkyl halide, because the degrees of ionization of both tautomeric salts are suppressed practically alike.

(*g*) The alkyl halide reacts with the anion; but the alkyl halide does not seem to react appreciably through (1) primary dissociation into alkyl and halide ions, as was assumed by Bruyn and Steger, nor (2) through the union of the alkyl halide with the cation and the formation of a complex cation which then reacts with the anion, as was assumed by Euler, nor (3) through a preliminary dissociation into a halogen hydride and an unsaturated alkylene or alkylidene residue, as was assumed by Nef. But mathematical reasoning alone led us to the conclusion that the alkyl halide may unite to a small extent with the urazole anion and form a complex anion which then yields the ester and the halide ion. A fundamental part of this problem is: (1) to determine experimentally the relation of the amount of the free energy of the different isomeric alkyl halides to their equilibrium constants when they change into each other; (2) to connect this with the constants expressing the formation of the complex anions by the union of each alkyl halide with the urazole anion, and the velocity of transformation of the complex anions; and (3) to harmonize this with the amount of free energy, and equilibrium constants, of the corresponding isomeric urazole esters which rearrange into each other. In general, whenever an alkyl halide (*n*-propyl bromide, *n*-butyl bromide, isobutyl bromide) changes reversibly nearly completely into another one (isopropyl bromide, secondary butyl bromide, tertiary butyl bromide, respectively), as Aronstein and Gustavson have found, then the former alkyl halide reacts far more rapidly with the urazole salts than does the alkyl halide which is formed by such a reversible rearrangement. We shall study this particular problem by the use of thermodynamics.

$$\bar{An}+\overset{+}{K}+C_2H_5I \rightleftarrows \bar{An}\cdot C_2H_5I+\overset{+}{K} \rightleftarrows AnC_2H_5+\bar{I}+\overset{+}{K}.$$

This complex anion theory has now been accepted by others and has been put on a firm basis by the isolation of several double compounds, such as $AgNO_3\cdot ICH_2CN$, which seem to have all the properties demanded by the theory.

Another problem of interest to us is the study of the action of acids, or alkalies, and water on amides, hydrazides, semicarbazides, oximes, esters, etc. According to our theory the hydrolysis of these sub-

stances should be analogous to the catalysis produced by alkalies on the reaction between alkyl halides and acids. According to this theory only the cations formed by the union of the H ion with the amide, oxime, hydrazide, etc., should be *appreciably* hydrolyzed.

$$CH_3CONH_2+\overset{+}{H}+\overset{-}{Cl}+H_2O \rightleftarrows CH_3CO\overset{+}{N}H_3+\overset{-}{Cl}+H_2O$$
$$\rightleftarrows CH_3COOH+\overset{+}{N}H_4+\overset{-}{Cl}.$$

This has been amply verified in this laboratory by Mr. Nirdlinger, and here we have a reaction of ions. We are studying, too, the *reverse* reactions: viz., the *formation* of amides, hydrazides, etc., by the action of ammonia, amines and hydrazines on the organic acids, esters or acid chlorides, with and without catalyzers, in different solvents, etc. We shall study especially the velocity of the reaction and the equilibrium in the gaseous phase.

In the case of the oxime, in which we have a reversible change as follows:

$$(CH_3)_2CO+\overset{+}{N}H_3OH \rightleftarrows (CH_3)_2C{=}\overset{+}{N}HOH$$
$$\rightleftarrows (CH_3)_2C{=}NOH+\overset{+}{H},$$

Dr. Johnson and Mr. Desha have discovered the first reversible reaction in which the so-called third law of catalysis fails to hold, in which the equilibrium point is changed by a change in the concentration of the catalyzer.

This theory of acid-catalysis allows us to predict that such cations will be found to react with alcohol, phenols, amines, hydrazines, etc. Dr. E. E. Reid has been able to show by the necessary quantitative measurements that the amides react with alcohols in the presence of acids and form quantitative yields of esters,

$$CH_3CO\overset{+}{N}H_3+HOR \rightleftarrows CH_3C\left\langle\begin{array}{l}OR\\ \overset{+}{N}H_3\\ OH\end{array}\right.$$
$$\rightleftarrows CH_3COOR+\overset{+}{N}H_4,$$

and that excellent yields of esters may be obtained also from anilides and hydrazides under the same conditions. This suggests that the ordinary Fischer esterification method for the isolation of amino acids in the form of their esters from casein, horn, hair, polypeptides, etc., might be effectively modified in some cases by boiling the substance in alcoholic hydrochloric acid instead of in aqueous solutions. The ester would then be formed directly instead of through the present indirect destructive methods.

$$\begin{array}{r|l|l|l}NH_2CH_2CO & NHCH_2CO & NHCH_2CO & NH_2\\ RO & H \qquad RO & H \qquad RO & H\end{array}$$

The chief disadvantage would be the insolubility of the proteid in the alcohol, but we find that our difficultly soluble compounds seem to work well.

Two other reactions, worked out by Dr. J. M. Johnson in our laboratory, are recalled, the simplest explanation of which is that *non-ionized salts* are transformed into other products. Acetyl chloraminobenzene and hydrochloric acid react with a velocity proportional to the concentration of the undissociated salt present, or to the *square* of the concentration of the hydrogen ions. Two other explanations of this reaction are to be considered, but as they are at present very improbable, they will be discussed in a later communication.

$$CH_3CONClC_6H_5+\overset{+}{H}+\overset{-}{Cl} \rightleftarrows CH_3CONHCl_2C_6H_5$$
$$\rightarrow CH_3CONHC_6H_4Cl+\overset{+}{H}+\overset{-}{Cl}.$$

The other reaction is one in which imidoesters of various types yield alkyl halides when heated with halogen hydrides. In this case, too, an undissociated salt seems to be decomposed.

$$ROCH_3+\overset{+}{H}+\overset{-}{Cl} \rightleftarrows ROCH_3\cdot HCl \rightarrow ROH+CH_3Cl.$$

This work disproves the validity of the so-called second law of catalysis, which postulated that there must be direct proportionality between the reaction velocity and

the concentration of the hydrogen ions in acid catalysis.

Professor Bredig, who, with his students, has made the chief contributions to the theoretical and experimental development of the idea that the catalyzer forms an intermediate compound, has written me that he too has recently discovered some reactions in which the non-ionized salt seems to be transformed into other substances.

We see, then, that the question whether the *anion* or *cation* (simple or complex) or the *molecular form* of a given acid, base, salt or other neutral substance, is the *chief* constituent transformed directly into the end products depends entirely upon the relative magnitudes of the various constants, and therefore varies widely in the different problems.

Occupying our attention in this connection is another phase of this work which should certainly be a great help to us in the solution of such problems. There is no method to-day for determining the concentrations of the constituents of such a reacting system as a mixture of acetamide, hydrochloric acid and water, in which

$$CH_3CONH_2+\overset{+}{H}+\overset{-}{Cl}+CH_3CO\overset{+}{N}H_3+\overset{-}{Cl}+$$
$$CH_3CONH_3Cl+H_2O \rightleftarrows CH_3COOH+\overset{+}{N}H_4+\overset{-}{Cl}, \text{ etc.,}$$

the salt undergoing transformation is very greatly hydrolyzed. The decrease in conductivity produced by adding acetamide to hydrochloric acid does not give us sufficient *knowns* to solve for the *unknowns* in the above equation. If some method were devised for determining the concentration of the hydrogen ions *nearly instantaneously*, then these problems could be solved. A colorimetric method involving the use of indicators seems to be out of the question with such concentrated solutions, but it may, in certain cases, work well in dilute solutions. But the use of the hydrogen electrode for the determination of the changing hydrogen ion concentration at any moment would seem to be very effective in those cases in which no disturbing side reactions take place, and this problem is engaging Mr. Desha's attention. Such a method, if successful, would be of great help in the study of a large number of reactions in acid, alkaline and other solutions.

Finally, organic chemistry is to-day a ripe field for the study of energy changes in reacting systems, as has been emphasized especially by Michael. The total energy of a system can in some cases be measured by studying the rate of formation or absorption of heat during the reaction in an adiabatic system. This has been done very satisfactorily by Bredig and Epstein in the decomposition of hydrogen peroxide by potassium iodide. Especially important is the study of free energy by the use of equilibrium and electrometric methods. A large number of organic reactions can be very easily arranged to take place in concentration cells in such a manner that the electromotive force can be readily and accurately measured. In order to study such cases completely the mechanism of the reaction must be known, and the values of all the constants, especially the equilibrium constant, must be determined accurately.

We are further using electrometric methods in the study of the question whether in the presence of platinum, iridium, etc., such substances as methane, ethylene, trimethylene, etc., can be made to dissociate as follows in substitution and addition reactions:

$$CH_2{=\!=}CH_2+2\oplus \rightarrow \overset{+}{C}H_2{-}\overset{+}{C}H_2+2\overset{-}{Br} \rightarrow C_2H_4Br_2,$$
$$CH_2{=\!=}CH_2+2\ominus \rightarrow \overset{-}{C}H_2{-}\overset{-}{C}H_2+2H \rightarrow C_2H_6,$$
$$CH_4+2\oplus \rightarrow \overset{+}{C}H_3+\overset{+}{H}+2\overset{-}{Br} \rightarrow CH_3Br+HBr,$$
$$CH_4 \rightarrow \overset{-}{C}H_3+\overset{+}{H}.$$

We see, then, that organic chemistry presents a large number of interesting prob-

lems that can and must be studied quantitatively. The solution of these problems will be not only of the greatest importance to abstract science and to industry, but will take first rank in giving an insight into the fundamental processes in plant and animal life, which involve both chemical and physical phenomena in homogeneous and heterogeneous systems.

These problems will, in my opinion and that of some of my physical chemical colleagues, be solved most easily by organic chemists, and not by physical chemists. The worker who would do great service to this branch of the science must have *as the great essential* such a broad and deep knowledge of organic chemistry that he can recognize wrong interpretations of reaction mechanisms almost by *intuition:* he must not make wrong postulations regarding reactions as Ostwald did in the *theory of indicators* and in the *catalysis of amides,* and as Euler did in the *saponification of esters,* mistakes which were corrected by *organic chemists.* Then he must turn to his physical chemistry and learn *three things well*—the mass law, thermodynamics and electrochemistry; even then he must constantly advise with some well-trained *real* physical chemist, and with some mathematician, who can to some extent understand the problems.

No man can do *trustworthy* work in physico-organic chemistry with half-way preparation, but the chemist who is well equipped will render great service to the science.

S. F. ACREE
JOHNS HOPKINS UNIVERSITY,
BALTIMORE, MD.,
December 30, 1908

BACTERIOLOGY AS A NON-TECHNICAL COURSE FOR PUBLIC SCHOOLS[1]

BACTERIOLOGY, a biological science as distinct from a useful art, has hardly received any material recognition as yet in this country. The writer would advocate the academic study of certain of its phases as illustrating the general bases of life, as a mental training, and as furnishing a field for thought.

Again realizing that sociology, in ultimate analysis, is strictly dependent upon and limited by biological laws, sociological teaching which neglects the biology and physiology of the individual neglects the study of its primal units. Hence the value of, even necessity for, the elementary biological training of the prospective sociologist. But sociology is more than the study of certain units in multiple. It is the study of the interrelations of these units. Therefore, the study of the anatomy and physiology of a single example of man (or for convenience and by analogy of the frog or the plant) furnishes no actual laboratory biological study analogous to the study of the interrelations of man in the world. Bacteriology supplies this missing link, for bacteriology deals hardly at all with the individual—almost wholly with aggregations of individuals. Symbiosis, antagonism—the effect of overcrowding, the survival of the fittest —coordination of partial efforts of different cooperating species to produce a sum total result—all these phases of sociology, chosen from many more for this address at random, can be illustrated in a bacteriological course —and with materials directly under control, subject to experimental variation and, from the rapidity of bacterial development, without waste of time.

Finally, beyond these purely scholastic views lies a practical value of bacteriology as a general study, especially for women, in that it furnishes an armamentarium in dealing with certain every-day problems of household life which come into play during at least one half of the conscious waking life of man and almost the whole of the conscious waking life of the alma mater of the family—the housekeeper and actual food provider, as the wife and mother must always be in nine tenths of the population. The writer will discuss the third of these phases, *i. e.,* bacteriology for its

[1] Presented at the Baltimore meeting of the Society of American Bacteriologists, December 31, 1908.

hygienic teachings, and especially for its technique, in more detail but still without any attempt to exhaust the subject, as a suggestion to those more actively engaged in pure teaching than himself.

Bacteriology for the General Student.—Huxley somewhere has said that if it were inevitable that every human being must at some time in his life play a game of chess against an expert, the stakes being his continued existence, then the parent or state might well be indicted for criminal negligence if no knowledge of the great game were taught. A better parable concerning the teaching of bacteriology to the general citizen could not well be offered. Surely if it is worth while for children to spend years in studying music, geography, the higher mathematics, the dead languages and many other subjects not strictly necessary to existence—most of which are never used by the great mass of the public, all of which, except in their simplest forms are quickly forgotten by the average citizen—all of which must be entirely relearned by the occasional individual who intends to become an expert in them—why should not children be taught the fundamentals of a subject of daily importance to them throughout the rest of their lives? The present teaching of physiology in the public schools is really academic, for so much of it as may have any slight reflex of physiological truth is but dimly understood by either the teacher or the child, and is at best quickly confused and forgotten. Moreover, the complicated nature of the whole teaching in modern physiology is such that even the physician can use little of it in practise and draws no deductions from it without the most exhaustive tests of his deductions before daring to apply them. What then can be the value of the deductions for leading a hygienic life which the child may draw from public-school physiology, when the fact is that he generally leaves school at fourteen or sixteen, *i. e.*, before his mental grasp is well developed? The best known investigators of the relatively simple questions of dietetics swing from one extreme to the other notwithstanding long years of intimate anatomical and physiological study in the most highly equipped laboratories. Within five years, minimum feeding; maximum feeding; complete mastication; bolting the food whole; a selected diet carefully weighed, measured and calculated; and free feeding at the dictates of the appetite have all been advocated by our "highest authorities." What can the study of a mere diagram of the intestinal tract and the learning of the names of different portions of the gut do in enabling the future citizen to decide how or what to eat? Consider the case of a native South Sea Islander if the study of a railway map of the Twentieth Century Limited, printed in a foreign language, and demonstrated by a fellow savage, be the sole available source of knowledge on the subject of railway transportation on which he is to decide what produce to ship and how and when to ship it?

Bacteriology as compared with physiology is a relatively simple matter. Its fundamentals are fixed; so far as deductions of value to the ordinary citizen are concerned, any one can make them who knows the merest rudiments. Its basic elements do not require for demonstration the elaborate apparatus and animal experimentation of the physiologist—the elements can be worked out in the kitchen—as the writer worked them out years ago. Imagine the whole population having even so much real first-hand experimental knowledge of bacteriology as a medical student at the end of his first three weeks' bacterial training. At least the principles of the transfer of unseen infection on hands and utensils would be known and the general rules as to distribution of bacteria, sterilization of foods, utensils, etc. Above all, the personal defense by the individual upon which must always rest the ultimate escape from infectious diseases would be understood and its simple methods learned. In the great campaigns now waging against tuberculosis and other infectious diseases in mankind, the education of the people is the great cry. Unfortunately this education has so far consisted chiefly in teaching the etiology, pathology, distribution and economics of disease—mere formularies to the average mind, like the statistics concerning alcohol

and intemperance in another field. The "education" ought to consist in teaching the individual how and what to *do, i. e.,* the simple bacteriological knowledge and simple bacteriological technique necessary to avoid "the swallowing, by one individual, of the discharges of other individuals." This knowledge, taught as the chief end of a simple bacteriological course, could be conveyed in lessons and class-room demonstrations, not of diagrams, but of real living bacteria, without involving the opposition engendered by anatomical or physiological demonstrations on living animals which alone will ever make physiology anything but a formula to the lay (or to any other) mind. That it should be taught in the elementary schools, and especially to the girls, is made clear by the two facts that the majority of children (about 80 per cent.) leave school before the high school[2] is reached, and that upon the girls as housekeepers and mothers must the family defense depend, as well as, by precept and example, the proper training of the children in the personal defense against infection.

Community defense against infection as contrasted with family and personal defense is a matter for the public health official, and the lack of this distinction between what is personal or family and what is public health seems to be a great stumbling block over which many earnest souls have fallen more than once. Public health must always deal largely with the prevention of the infection of public utilities with human discharges—especially infected human discharges; while family and personal defense is a matter (primarily) for the mother. When it is remembered that the great mass of all the infectious diseases of the country, especially in children, are necessarily handled and nursed, not in hospitals by trained nurses but inevitably and necessarily by mothers, so that the greatest single factor in the spread of infection from the recognized case, at the present time, outside of public utilities, is again inevitably and necessarily the mother, then the training of the prospective mother in simple bacteriologic technique, at first apparently a wild dream, becomes a most practical and serious problem. Educators in bacteriology should most earnestly ask themselves if the invaluable information concerning the existence, distribution, and above all the avoidance, of bacterial infection which to them is a mere commonplace should not be widely distributed amongst the people. Are the bacteriologists of the country doing their whole duty in confining their teaching to students of the arts of medicine, public health, industry and agriculture? Is not the time ripe for a propaganda for the teaching of bacteriology to the masses? The trained bacteriologist may pass unscathed through fifty epidemics of the ordinary infectious diseases—not because of anatomical or physiological training, not even because of epidemiological knowledge—but wholly because he understands the simple elements of bacterial aseptic technique and follows them logically and consistently. Surely it is the duty of the bacteriologist to pass on the simple technique of bacteriological asepsis at least to the people at large. It is not for the physician to do it—except at the bedside and for the individual case. It is for the bacteriological teacher to enforce personal defense against infection amongst the well before the bedside is reached—to furnish the groundwork upon which the physician may build on occasion. Such courses should be given in the public schools in such grades as to reach the children between eight and sixteen years old; these courses should consist in their simplest form of demonstrations, through use of agar or gelatin plates, of the existence, and distribution of bacteria in air, water, milk, dust, feces, etc., and especially on hands: extending somewhat in scope and in individual experimental work as the grades are ascended. Microscopes would not be essential and the necessary apparatus and media could be furnished at a very low cost.

In the high schools, gradual advance in the detail of experiments should be arranged with

[2] It seems unlikely that more than 20 per cent. of the population receives high school education; or more than 1 per cent. a university education.

quantitative experiments, possibly some species work and the microscope should be introduced.

In the university academic and especially in university sociologic courses the most intricate problems of interrelations of bacteria to each other as illustrating similar interrelations in human life might be conducted. Of course all this presupposes a bacteriological training of the teachers of the public and high schools.

For the present, the education of the mothers of the present might be attained, as suggested by Dr. Norman MacL. Harris, through lectures and simple "courses" given before mothers, in connection with settlement work or in the mothers' meetings sometimes held in connection with the graded schools: women's clubs might secure teachers ready to give short courses in elementary laboratory work. Perhaps "correspondence courses" in the great journals devoted to women might, under proper supervision, stimulate many mothers to do a little elementary bacteriology at home. However done, it is the writer's belief that until such teaching is done—and done by methods involving not merely lectures or demonstrations but personal experiments by the mothers (present and prospective) themselves, the methods of personal defense against infection will never so take their proper place as to be real factors in the suppression of disease. Only when the "cleanliness" of fresh collars and cuffs and nicely brushed hair, etc., has added to it the real cleanliness of hands free from the discharges of the toilet room will personal cleanliness mean anything in relation to infection.

H. W. Hill

Minnesota State Board of Health Laboratories

TEACHING BY THE LECTURE SYSTEM

At an open meeting held a short time ago by the Case School chapter of the society of Sigma Xi, for the discussion of subjects of special interest to the members of the instructing staff at the Case School of Applied Science the lecture system was discussed. The different ideas presented seemed to suggest that a paper on this subject might be of some interest and possible benefit. I shall not discuss the efficiency of the lecture system as compared with other systems of teaching a science, since there can be little doubt but that under existing conditions this method if properly carried out is by far the best one for most sciences; but I shall treat of the various means of carrying it out and try to indicate those which seem best suited to attain the highest efficiency.

It is not the purpose of this paper to give in detail a full treatment of the different points to be considered in presenting a science course by the lecture system, but rather to collect a few facts and ideas which may, in this way, come to some who possibly have not been placed in an environment which would demonstrate the importance of the matter, and who have therefore not put as much thought on this particular question as efficient teaching would demand. A science should be presented in such a manner as will make its particular group of natural phenomena understood with the least possible expenditure of mental exertion and time on the part of the student. The presenting of a science in this manner should be the aim of the science teacher. Further, the teacher should strive so to correlate facts and suggestion that the phenomena and their explanation should be the most easily remembered.

In most of our schools, existing conditions make the lecture system by far the best for presenting a science to a class of students. This fact is more especially true in a largely experimental science, such as in chemistry or in physics. As the teaching of chemistry has been the vocation of the writer, what follows will probably apply more to the teaching of chemistry than to the teaching of any other science. The question then resolves itself into: what is the best method for conducting a lecture course so that its qualities shall be clearness, comprehensiveness, individual completeness and individual broadness? It is not alone sufficient to give a man knowledge. The subject must be presented to him in such a manner as to interest him sufficiently to make

him exert himself to learn it. Care must also be taken to show him where he can find the more detailed information. It does not suffice to teach any subject from one point of view. The failure to present a subject broadly turns out narrow men. It is broad men the world demands and these are moulded by viewing a subject from as many different standpoints as possible. For the broadest diffusion of knowledge, men of different years should be given somewhat different standpoints and shown where to find their knowledge somewhat differently. A hard-worn path should not be followed. A lecturer who writes a set of notes which he intends to follow year after year, without revision, soon finds that his intention was unsound. A lecture on almost any portion of a fast-growing science like chemistry needs more or less revision every time it is given.

Since, therefore, the straight lecture course with no reference books, text-books or mimeograph notes gives the student but one point of view, that of the lecturer, such a course is to be censured in all cases where it is possible to give it otherwise. There may be two classes of teachers who might use this method where it is not necessary: those who have had a limited experience and who are fearful that they might, for the time being, forget some of the details which the students might wish to discuss; and those who are omniscient. The first class will soon realize the fact that no man can have everything at his tongue's end, but that a teacher must be familiar in considerable detail with the subject he is teaching if he is to be at all successful.

The lecture course with mimeograph notes by the professor may be permissible in three cases: where there is no suitable text-book or reference book, where such a book is so expensive that the teacher does not feel justified in requiring the students to buy it, or where certain directions for laboratory use are, for special reasons, to be taken from the larger reference books or from the more recent literature. The dictation of such directions is perhaps allowable in a very few cases, but not for any extended course. The dictation of a complete course of laboratory directions is little less than a waste of time both for the students and for the teacher.

When we consider carefully the lecture course accompanied by a suitable text-book or reference book, by frequent recitations or conferences, and by occasional written exercises, we shall probably find the most efficient method, at least for all experimental sciences. Let us here distinguish between text-books and reference books. A true text-book should be brief and to the point, as supposedly it is to be gone over page by page. At present, however, there are a number of so-called text-books which are so much padded and cover so much ground in detail that they are entirely unsuited for this purpose. There seems to be a tendency to use such large books as text-books, with the false idea that a better course can be given, whereas in reality the student is so confused that his course becomes a chaos of facts and directions. This of course applies more especially to beginners. What can be more absurd than the placing of books like Frezenius's "Qualitative Analysis" or "Quantitative Analysis" in the hands of beginners in these subjects? The most efficient text-books for these courses comprise few and very definite directions, with explanatory notes. In an advanced course, when the student has been fairly launched in the subject, a more complete book may be used, which is not to be considered as a text-book, but more as a reference book from which suitable exercises may be selected.

The lecture itself can not do all the teaching. It should, however, lead, interest and inspire the student. The subject matter should be covered as completely as the time will allow, but not so rapidly that the average student can not grasp it readily. In order that the student should get the most out of a lecture he should be required to read carefully the corresponding pages in the accompanying reference book before the lecture takes place. The references of the pages to be covered at each lecture should be given at the previous lecture. The student should by all means study these pages in conjunction with his notes the same day the lecture is given..and more diligently the parts which were empha-

sized in the lecture. To interest the student as well as to insure greater clearness, as many typical experiments as possible should be carried out on the lecture table if the course is a complete one. If the course is only a preliminary one these experiments may be wholly or partially omitted. The manner of presenting the experiments has a large influence in communicating inspiration to the students as well as does the personality of the lecturer. To have this inspiring effect in the highest degree the lecturer must above all use good English and so choose his words that the least possible effort on the part of the student is required to comprehend the subject. The experiments must go smoothly. No muddy, half-way experiments should have a place on the lecture table. The man who has the reputation of never having an experiment fail always tries his experiments carefully before the lecture. The giving of experiments with a three-minute preparation nearly always results in few experiments and many failures. This always gives the students less respect for and less confidence in the lecturer, and the qualities which the lecturer should endeavor to have in his lecture, those of interesting and inspiring the students, are lost.

The holding of frequent recitations is an important adjunct in order to get the best results from a lecture course. Recitations hold the student to study, emphasize the important parts of the subject, give opportunity for explaining points upon which the individual student may be hazy, and give the student practise in expressing himself. These recitations should not be the reciting of a strict page by page text-book assignment, but consultations on the subject matter outlined in the lecture, whether given in the lecture or studied in the assigned reference book, or found in other available reference books. The student should always be encouraged to look up points upon which he is not clear and the books where he is likely to find the information suggested to him.

Suppose a lecturer treats in his lectures exactly the same material as is given in the reference book, or more than is given in it. The question might be asked: what is the use of a reference book under these conditions? The reference book still has the greatest value. The student has his book and can refer to it any time he feels so inclined. He can not apply to the instructor at all times as he can to his book. The student also acquires a knowledge of the subject from two standpoints: the lecturer's and the author's. In the event of recitations he may get still another standpoint. This broadening of view is still better attained by changing the assigned reference or text-book from year to year. This can readily be done in many subjects, especially those of a general nature. This changing of reference books has admirable effects. In different years it turns out men with slightly different standpoints. In the main what they learn is the same, but they do not get it in exactly the same relation; and the men graduating from a school where this custom is practised are likely to be, as a body, broader than those from a school where it is not. Another most important effect of changing the reference book from year to year is the keeping of the teacher from a rut. A lecturer, to continue successful, must keep up to the times and must do it broadly. It would seem that the using of a different reference book from year to year, as before mentioned, is also commendable as being in keeping with a broadness of presentation by the lecturer. A set of lecture notes should necessarily be revised each year, the newer facts and discoveries inserted and the old replaced as necessary. It is imperative, and the mentioning of it here may perhaps seem absurd since it can scarcely be believed that any one in the teaching profession should lose sight of its importance. This keeping apace with the times is certainly worthy of as much thought and attention as the imparting of knowledge, if not more so.

Norman A. Dubois

Case School of Applied Science,
March, 1909

KAKICHI MITSUKURI

Advices from Japan report the death, on September 16, of Dr. Kakichi Mitsukuri, dean of the College of Science in the Imperial University of Tokyo. Dr. Mitsukuri was one

of the leaders of modern Japanese thought—perhaps the most effective scholar in his relation to public affairs which Japan has ever produced. In his special line of zoology, he was the author of numerous papers; and his influence in his own field has been still more marked by the development of many young men, and by the establishment of the Seaside Laboratory at Misaki, where much excellent work has been done by Japanese, as well as by American and European naturalists.

Dr. Mitsukuri was born in Edo, Japan, on December 1, 1857. He was the second son of Shuhyo Mitsukuri, a retainer of the former feudal lord of Tsuyama. After passing through the local schools, Mitsukuri came to America in 1873, and entered the Hartford Academy, in Connecticut. The next year he attended the Troy Polytechnic School, and two years later he entered Yale, where he received the degree of Ph.D. in zoology in 1879. In 1881, he studied zoology under Professor Balfour, of the University of Cambridge. Returning to Japan, he was appointed a professor of zoology, in 1882, in the science department of the University of Tokyo. In 1883, he received the degree of Ph.D. in zoology from Johns Hopkins University. In 1893, he was appointed councilor of the Imperial University. In 1896, he was made head of a commission for the investigation of the fur seal, and in 1897, he signed in behalf of Japan a treaty whereby Japan agreed for a certain length of time to consent to any adjustment of this matter which might be made by Great Britain and the United States. In 1901, Dr. Mitsukuri was made dean of the College of Science of the Imperial University of Tokyo. In 1907, he was awarded the Order of the Sacred Treasure, in recognition of his public relations.

Dr. Mitsukuri's grandfather, Dr. Gempo Mitsukuri, is well known as the pioneer Dutch scholar of Japan. His father was also noted, as a student of Chinese classics. His uncle was one of the most noted jurists of his time. His elder brother, now deceased, was also an eminent scholar. His third brother is Baron Kikuchi, who was president of the University of Tokyo, and afterwards at the head of the public school system of Japan. His name was changed from Mitsukuri to Kikuchi, in accordance with the Japanese custom of adoption, he having been adopted into the family of one of his relatives. A younger brother is still a professor of history in the college of literature.

Of late years, Dr. Mitsukuri was engaged in the special study of the turtles. He was also largely occupied with matters of administration. He was one of the best representatives of the scholar in public life which modern Japan has produced. He had a most thorough knowledge of the English language, and of affairs in America, and his intense sympathy with American point of view caused him to be invaluable in the preservation of good feeling between these two nations which in modern times have come to border upon each other.

This is illustrated in the following extract from a personal letter written by Dr. Mitsukuri to the present writer in the year 1900.

> The history of the international relations between the United States and Japan is full of episodes which evince an unusually strong and almost romantic friendship existing between the two nations. In the first place, Japan has never forgotten that it was America who first roused her from the lethargy of centuries of secluded life. It was through the earnest representations of America that she concluded the first treaty with a foreign nation in modern times, and opened her country to the outside world. Then, all through the early struggles of Japan to obtain a standing among the civilized nations of the world, America always stood by Japan as an elder brother by a younger sister. It was always America who first recognized the rights of Japan in any of her attempts to retain autonomy within her own territory. A large percentage of foreign teachers working earnestly in schools was Americans, and many a Japanese recalls with gratitude the great efforts his American teachers made on his behalf.
>
> Then, kindness and hospitality shown thousands of youths who went over to America to obtain their education have gone deep into the heart of the nation, and, what is more, many of these students themselves are now holding important positions in the country, and they always look back with affectionate feelings to their stay in America. Again, such an event as the return of the Shimonoseki indemnity—the like of which is

seldom witnessed in international relations—has helped greatly to raise the regard in which America is held by the Japanese.

Neither is it forgotten how sympathetic America was in the late Japan-China war.

Thus, take it all in all, there is no country which is regarded by the largest mass of the Japanese in so friendly and cordial a manner as America.

It is, therefore, with a sort of incredulity that we receive the news that some sections of the American people are clamoring to have a law passed prohibiting the landing of Japanese in America. It is easily conceivable to the intelligent Japanese that there may be some undesirable elements among the lower-class Japanese, who emigrate to the Pacific coast, and if such proves to be the case, after a due investigation by proper authority, the remedy might be easily sought, it appears to us, by coming to a diplomatic understanding on the matter, and by eliminating the objectionable feature. The Japanese government, would, without doubt, be open to reason.

But to pass a law condemning the Japanese wholesale, for no other reason than that they are Japanese, would be striking a blow at Japan at her most sensitive point. The unfriendly act would be felt more keenly than almost anything conceivable. An open declaration of war will not be resented as much.

The reason is not far to seek. Japan has had a long struggle in recovering those rights of an independent state which she was forced to surrender to foreign nations at the beginning of the intercourse with them, and in obtaining a standing in the civilized world. And if, now that the goal is within the measurable distance, her old friend, who may be said in some sense to be almost responsible for having started her in this career, should turn her back on her, and say she will no longer associate with her on equal terms, the resentment must necessarily be very bitter.

The entire loss of prestige in Japan may not seem much to the Americans, but are not the signs too evident that in the coming century that part of the world known as the "Far East" is going to be the seat of some stupendous convulsions from which great nations like America could not keep themselves clear if they would? And, is it not most desirable that in this crisis those countries which have a community of interests should not have misunderstandings with one another? It is earnestly to be hoped that the American statesmen will estimate those large problems at their proper value, and not let them be overshadowed by partisan considerations.

For my part, I can not think that the American people will fail in this matter in their sense of justice and fair play toward a weaker neighbor, and such a movement as the present must, it seems to me, pass away like a nightmare. But, if ever a law should be passed directed against the Japanese as Japanese, it will be a sorrowful day personally to me.

It was my good fortune to pass several years of my younger days in two of the great universities of America, and to be made to feel at home as strangers seldom are. I would rather not say in what affection I hold America, lest I be accused of insincerity, but this much I may say, that some of the best and dearest friends I have in the world are Americans.

But the day such a law as spoken of should be enacted, I should feel that a veil had been placed between them and myself, and that I could never be the same to them and they to me. May such a thing never come to pass!

David Starr Jordan

THE WESTERN EXCURSION FOLLOWING THE WINNIPEG MEETING OF THE BRITISH ASSOCIATION

Following the meeting of the British Association at Winnipeg a party of 180 officers and guests of the association took a most delightful excursion over the Canadian Pacific and Canadian Northern railways westward from Winnipeg.

The party left Thursday night, September 2, in a train of twelve cars, composed of nine Pullman sleepers, two dining cars and one baggage car.

On Friday, September 3, a stop was made at Regina, the capital of Saskatchewan, from 11:00 A.M. to 4:00 P.M. The citizens of Regina met the party with carriages and automobiles and showed off their young town to the best advantage. Lunch was served in the new city hall, speeches followed, and then a trip was made to see the finely equipped mounted police of this region.

At 5:30 a stop was made at the young boom town of Moose Jaw, where the party was met by a brass band and led up the main street under an arch composed of the products of the region. Supper was served in the skating rink as there was no other building in the town large enough to seat the three to four hundred citizens and guests. The party then returned to the sleepers and the train pulled out during the night and started across the Great Plains. Up to 4 o'clock

on Saturday views of fertile wheat fields of Canada were seen from the car windows, when the party arrived at one of the most attractive of the young, rapidly growing, Canadian cities of the northwest—Calgary.

A most hospitable, intelligent and energetic group of citizens met the party with carriages and automobiles and, under the direction of the mayor, carried them over a vast extent of territory and showed the great possibilities of the future city of Calgary. The prices of real estate in this region will not remain stationary twenty-four hours, according to all accounts. Supper was served in the parlors of the methodist church, after which speeches were made by the mayor, President Thompson and others. The train remained at Calgary until early Sunday morning so that the trip into the Rockies could be taken in the daylight.

Stops were made at Banff and Laggan, and these two remarkably picturesque resorts in the Canadian Rockies were seen as thoroughly as the limited time would allow. Early Monday morning the train left Laggan and went down the western slope of the Rocky Mountains across the Columbia River and climbed up the Selkirks.

A stop was made at Glacier from 9:00 A.M. to 1:35 P.M. and the party indulged in all kinds of glacial activities.

Revelstoke on the Columbia was passed Monday afternoon and the party enjoyed seeing the beautiful red salmon ascending the head waters of the Frazier River.

Tuesday morning the party reached Vancouver and took the steamer about an hour later to Victoria. The four and a half hour sail from Vancouver to Victoria was one of the most enjoyable portions of the whole trip. The steamer passed the delta of the Frazier River, then across the Straits of Georgia past the islands on the west side. The route of the steamer is a very interesting one among charming islands, with remarkable developments of very youthful shorelines.

Tuesday afternoon was spent at Victoria, and Tuesday evening was the one formal reception of the whole trip in the magnificent parliament buildings of British Columbia.

Wednesday morning the party was divided into groups, some to take automobile trips, some boat trips, and some to visit local points of interest. At 2:00 P. M. the return trip was made through the islands to Vancouver where at 8:00 P. M. Sir William White gave a public lecture on the British navy.

Thursday, September 9, was spent in the rapidly growing commercial city of Vancouver; this city being the western terminus of the Canadian Pacific Railway, and having a remarkably fine harbor which has developed at a very rapid rate in the past few years. Its commerce is increasing almost daily and the great importance of this city in the future is assured. One may call it the Liverpool of western Canada.

At 5:00 P.M. on Thursday the party went back to the sleepers and started on the return trip. Only short stops were made on the return across the Selkirks and the Canadian Rockies.

On Saturday morning the party reached the most northern point of the trip, and entered perhaps the most attractive and remarkable of the new cities of western Canada; Edmonton, the capital of Alberta, on the North Saskatchewan River. Edmonton, instead of being the jumping-off place as one might suppose from a casual inspection of the railroad map, is the meeting place of three lines of transportation: the railroad, the river and the dog-trains. The citizens of this place are building it up in a very broad-minded manner, looking to an assured future when this city will have several hundred thousand inhabitants.

The party was entertained at dinner in the large upper hall of the Roman Catholic Separate School, and speeches were made here as usual, after which the party went down to the old Hudson Bay Fort, which some of the older members remembered as the only building in Edmonton when they first came to the Saskatchewan River. A boat trip on this river showed the coal mines, gold washing, the new bridge of the Grand Trunk Pacific Railway, etc.

The party left Edmonton Saturday night over the Canadian Northern and reached Winnipeg early Monday morning.

F. P. GULLIVER

FOREST PRODUCTS INVESTIGATION

PREPARATIONS have been completed for the transfer of all the government's forest products work to Madison, Wisconsin, where the U. S. Forest Service Products Laboratory will be located, and to Chicago where the headquarters of the office of wood utilization will be established.

The new Forest Products Laboratory being erected at Madison by the University of Wisconsin, which will cooperate with the government in its forest products work and which

is to cost approximately $50,000, is now in the course of construction. The laboratory will be a fire-proof building of brick trimmed in white stone and is located near the Chicago, Milwaukee & St. Paul Railroad, with exclusive tracks and other railroad facilities. The building is expected to be ready for occupancy upon January 1. In the meanwhile temporary offices will be provided.

On October 1 the Yale Timber Testing Laboratory was discontinued and the forest service equipment there shipped to Madison. The laboratory at Washington was discontinued at the same time. The Timber Testing Laboratory at Purdue, Indiana, will be operated until the middle of December when it will be discontinued and its equipment shipped to Madison.

The offices having general supervision over all the work of the branch of products will remain temporarily in Washington. W. L. Hall, assistant forester, continues in charge of Branch of Products and McGarvey Cline will be director of the Madison Laboratory. The work of the laboratory will be assigned to five offices, as follows:

Wood Preservation, which will study all problems related to the impregnation of wood with preservatives and other substances.

Wood Chemistry, which will handle all work bearing on the chemical utilization of forest products. Wood distillation, paper pulp and other fiber products, chemical analyses of creosotes, turpentines, etc., are the principal lines handled by this office.

Timber Tests, which will have charge of all tests to determine the strength and other mechanical properties of different woods.

Technology, which will study the microscopic structure of wood, methods of seasoning and drying it, and other problems of a purely technical character.

Maintenance, which will have charge of the filing and computing. It will also be responsible for the purchase of supplies and general care of the entire laboratory.

The class of work in the laboratory may be separated into three kinds, as follows:

1. The investigation of problems in experimental research.

2. Experimental work in cooperation with commercial plants to verify laboratory experiments on a commercial scale.

3. Cooperation with outside parties for the purpose of assisting them in applying principles and processes of recognized commercial value with which the service is thoroughly familiar.

The supervisory staff of the laboratory is as follows:

McGarvey Cline, Director.
H. S. Bristol, in charge of Wood Chemistry.
H. D. Tiemann, in charge of Technology.
H. F. Weiss, in charge of Wood Preservation.
Rolf Thelen, in charge Timber Tests.
W. H. Kempfer, in charge of Maintenance.

The technical force will in part be made up of the following men:

H. E. Surface, engineer in wood chemistry.
Edwin Sutermeister, wood pulp investigations.
Jason L. Merrill, chemist.
E. Bateman, chemist.
L. F. Hawley, wood distillation investigations.
Frederick Dunlap, kiln drying investigations.
C. D. Mell, microscopist.
W. D. Brush, microscopist.
C. J. Humphrey, pathologist, detailed from the Bureau of Plant Industry.
F. W. Bond, mechanical engineer.
E. W. Ford, mechanical engineer.
C. T. Barnum, mechanical engineer.
C. P. Winslow, civil engineer.

The work of the office of wood utilization at Chicago will consist of studies of the wood-using industries of various states, the study of woods in manufacture and of the methods of disposing of mill waste, the collection of statistics on the price of lumber at the mill and at the principal distributing markets of the country, and the study of specifications and grading rules. The office will also secure statistics of forest products of importance to the experimental work of the service and the study of the movements of lumber and of the conditions of the principal lumber markets.

The personnel of the office of wood utilization for the present is as follows:

H. S. Sackett, in charge.
Hu Maxwell.

Franklin H. Smith.
Roger E. Simmons.
Charles F. Hatch.

AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

THE twenty-second annual meeting of this association will be held in Boston, Mass., on Tuesday and Wednesday, December 28 and 29, 1909, during the week of the winter meeting of the American Association for the Advancement of Science.

For the program to be made up so that it can be included as a part of the official program of the latter association and so that it can be placed in the hands of the members before the meeting it will be necessary for all titles of papers that are to be presented to be in the hands of the Secretary November 15. The length of time desired for each paper should be stated after the title, and attention is called to the action taken at the Chicago meeting whereby the secretary was directed to request members to present each paper within a fifteen minute time limit.

An arrangement has been made whereby the meeting of the Association of Horticultural Inspectors will begin on Monday, December 27, and the meeting of the Entomological Society of America will convene on Thursday and Friday, December 30 and 31, thus preventing duplication in the time of holding these meetings and giving the members an opportunity of attending all the sessions.

It is expected that an extensive exhibit will be made illustrating the New England insect fauna, together with a special display of equipment and devices for rearing and distributing beneficial species, as well as for treating noxious ones in the field.

A large number have already signified their intention of attending the meeting and the local entomologists will spare no pains to make this the most interesting and profitable one that has been held by the association.

DR. W. E. BRITTON,
President
A. F. BURGESS,
Secretary

THE ROCKEFELLER COMMISSION FOR THE ERADICATION OF HOOKWORM DISEASE

MR. JOHN D. ROCKEFELLER has given the sum of $1,000,000 to combat the hookworm disease and has selected a commission to administer the fund which consists of

Dr. William H. Welch, professor of pathology in Johns Hopkins University, president of the American Medical Association.

Dr. Simon Flexner, director of Rockefeller Institute for Medical Research.

Dr. Ch. Wardell Stiles, chief of the division of zoology, United States Public Health and Marine Hospital Service, discoverer of the prevalence of the disease in America.

Dr. Edwin A. Alderman, president of the University of Virginia.

Dr. David F. Houston, chancellor of Washington University, St. Louis, Mo.

Professor P. P. Claxton, professor of education in the University of Tennessee.

J. Y. Joyner, state superintendent of education in North Carolina and president of the National Educational Association.

Walter H. Page, editor of the *World's Work*.

Dr. H. B. Frissell, principal Hampton Institute.

Frederick T. Gates, one of Mr. Rockefeller's business managers.

Starr J. Murphy, Mr. Rockefeller's counsel in benevolent matters.

John D. Rockefeller, Jr.

Mr. Rockefeller's letter to the members of the commission is as follows:

NEW YORK, Oct. 26, 1909.

Gentlemen: For many months my representatives have been inquiring into the nature and prevalence of "hookworm disease" and considering plans for mitigating its evils. I have delayed action in this matter only until the facts as to the extent of the disease could be verified and the effectiveness of its cure and prevention demonstrated. The wide distribution and serious effects of this malady, particularly in the rural districts of our southern states, first pointed out by Dr. Charles Wardell Stiles, of the United States Public Health and Marine Hospital Service, have now been confirmed by independent observations of the distinguished investigators and physicians, as well as by educators and public men of the south.

Knowing your interest in all that pertains to the well-being of your fellowmen, and your acquaintance with this subject, I have invited you to a conference in the hope that it may lead to

the adoption of well-considered plans for a co-operative movement of the medical profession, public health officials, boards of trade, churches, schools, the press and other agencies for the cure and prevention of this disease. If you deem it wise to undertake this commission I shall be glad to be permitted to work with you to that end and you may call upon me from time to time for such sums as may be needed during the next five years for carrying on an aggressive campaign, up to a total of one million dollars ($1,000,000).

While it would be a privilege to act in any movement which offers assurance of relieving human suffering, it is a peculiar pleasure to me to feel that the principal activities of your board will be among the people of our southern states. It has been my pleasure of late to spend a portion of each year in the south and I have come to know and to respect greatly that part of our country and to enjoy the society and friendship of many of its warm-hearted people. It will, therefore, be an added gratification to me if in this way I may in some measure express my appreciation of their many kindnesses and hospitalities.

Very truly,

John D. Rockefeller

The reply was signed by all the members of the commission, and was as follows:

New York, Oct. 26, 1909.

Mr. John D. Rockefeller,
New York City.

Dear Sir: Your generous offer to pay such sums as may be needed during the next five years up to a total of one million dollars to carry on a scientific and popular campaign for eradicating "hookworm disease" has our heartiest approbation and we accept your invitation to administer this trust with a keen appreciation of the opportunity that you give us to do a great public good. We have to-day taken steps for organization and incorporated for practical work and have named this board the "Rockefeller Commission for the Eradication of Hookworm Disease."

The "hookworm" parasites often so lower the vitality of those who are affected as to retard their physical and mental development, render them more susceptible to other diseases, make labor less efficient, and in the sections where the malady is most prevalent, greatly increase the death rate from consumption, pneumonia, typhoid fever and malaria. It has been shown that the lowered vitality of multitudes long attributed to malaria and climate and seriously affecting economic development, is, in fact, largely due in some districts to this parasite.

The disease is by no means confined to any one class; it takes its toll of suffering and death from the highly intelligent and well-to-do as well as from the less fortunate. It is a conservative estimate that two millions of our people are infected by this parasite. The disease is more common and more serious in children of school age than in other persons. Widespread and serious as the infection is, there is a most encouraging outlook. The disease can be easily recognized, readily and effectively treated and by simple and proper sanitary precautions successfully prevented. The undertaking proposed by you is therefore not only full of promise of great benefit, but is eminently definite and practicable. We desire, individually as well as collectively, to thank you for this opportunity to be of service to our fellowmen and we enter upon our task with a deep sense of the responsibility laid upon us.

SCIENTIFIC NOTES AND NEWS

The National Academy of Sciences will meet at Princeton University, beginning on Tuesday, November 16.

Birmingham University held on October 20 its first congregation for the conferring of honorary degrees. The degree of LL.D. was conferred on Mr. Balfour, Mr. Chamberlain, Mr. Andrew Carnegie and other distinguished guests, including the following men of science: Sir William Crookes, Sir Archibald Geikie, Sir Joseph Larmor, Sir Douglas Powell, Sir William Ramsay, Lord Rayleigh, Professor Rutherford, Professor Silvanus Thompson, Professor Tilden and Sir J. J. Thomson.

At the meeting of the New York Section of the American Chemical Society, on November 5, the Nichols medal will be awarded to Dr. L. H. Baekeland for his papers on "The Synthesis, Constitution and Industrial Application of Bakelite" and "Soluble and Fusible Resinous Condensation Products of Formaldehyde and Phenol."

Mr. Shackleton was presented with a gold medal of the Royal Society of Geography at Brussels and a diploma of honorary membership after lecturing before the society on October 20.

DR. JULIUS WIESNER, professor of botany at the University of Vienna, has retired from active service.

PROFESSOR J. VOSSELER, director of the Biological Station at Amani, has been appointed director of the Zoological Garden at Hamburg.

DR. G. LOPORIORE has been appointed director of the Agricultural Station at Modena.

MR. JULIAN S. HUXLEY, B.A., late scholar of Balliol College, Oxford, has been elected to the biological scholarship at Naples for 1909. Mr. Huxley, who is a grandson of the late Professor Huxley, gained the Newdigate prize for English verse in 1908.

THE Liston Victoria jubilee prize of the value of £100, which is awarded every fourth year by the Royal College of Surgeons, of Edinburgh, to the fellow or licentiate of the college who has done the greatest benefit to practical surgery during the period since the last award, has been adjudged to Mr. Robert Jones, of Liverpool.

THE following awards by the British Institution of Mining and Metallurgy have been announced: The gold medal of the institution to Professor William Gowland, who has recently vacated the chair of metallurgy at the Royal School of Mines, in recognition of his services in the advancement of metallurgical science and education. The "Consolidated Goldfields of South Africa (Limited)" gold medal to Mr. W. A. Caldecott for his work in the investigation of methods of reduction and treatment of gold ores. The "Consolidated Goldfields of South Africa (Limited)" premium of 40 guineas conjointly to Mr. C. O. Bannister and Mr. W. N. Stanley, in recognition of their work in the investigation of the thermal property of cupels, and for their joint paper on "Cupellation Experiments."

IN accordance with the recommendations of the recent departmental committee on the West African Medical Staff, the secretary of state for the British colonies has appointed the following men to be an advisory committee on medical and sanitary questions connected with the British colonies and protectorates in tropical Africa: Mr. H. J. Read, C.M.G., of the Colonial Office (chairman); Sir Patrick Manson, K.C.M.G., M.D., F.R.C.P., F.R.S., senior lecturer, London School of Tropical Medicine; Sir Rubert Boyce, M.D., F.R.S., dean of the Liverpool School of Tropical Medicine; Mr. C. Strachey, of the Colonial Office; Mr. W. T. Prout, C.M.G., M.B., late principal medical officer, Sierra Leone; Mr. Theodore Thomson, C.M.G., M.D., of the local government board; Mr. W. J. Simpson, C.M.G., M.D., F.R.C.P., professor of hygiene, King's College, London; Mr. J. K. Fowler, M.A., M.D., D.Sc., F.R.C.P., late dean of the faculty of medicine, University of London.

DR. ALLAN KINGHORN, who has recently returned from northeast Rhodesia and central Africa, where he was sent by the Liverpool School of Tropical Medicine, together with Mr. R. E. Montgomery, to investigate the sleeping sickness there, has been appointed by the secretary of state for the colonies to proceed to West Africa where he will continue his work on the sleeping sickness. Since his return from Africa Dr. Kinghorn has been engaged at the research laboratories of the school, and together with Mr. Montgomery has completed a report of the Zambesi Sleeping Sickness Expedition. Mr. Montgomery has been appointed to a post under the Colonial Office in British East Africa at Nairobi.

BY the will of the late Mr. Mitchel Valentine, after a few minor bequests have been given, the residue of the estate, valued at $2,000,000, is to be divided equally between the Presbyterian Hospital and Hahnemann Hospital of New York.

MR. ANDREW CARNEGIE has given 450 acres of land as the site for a sanitarium for tuberculosis patients. The land is at Cresson, Pa., at an elevation of 2,400 feet.

THE Mount Weather Research Observatory of the United States Weather Bureau has just completed its first sounding balloon campaign in the west. Small rubber sounding balloons were sent up simultaneously at two points, viz., Fort Omaha, Nebr., and Indianapolis,

Ind. Thirteen ascensions were made at Fort Omaha and seven at Indianapolis. Owing to an unforeseen difficulty at the last-named place the full program could not be completed. All the meteorographs sent up at Indianapolis have been recovered and thus far about one half of the Omaha instruments have been returned.

The American Academy of Medicine will hold its third mid-year meeting at Yale University on November 11 and 12, when it will conduct a conference on "The prevention of infant mortality." There will be four sessions devoted, respectively, to medical, philanthropic, institutional and educational prevention, before which papers will be presented by distinguished speakers.

Dr. Von Brunck, of the "Badische Anilin," has made a gift of 50,000 Marks to the Munich Academy on the occasion of the fortieth anniversary of his entry in the industry.

Nature states that prizes to the value of £1,500 are offered by the National Medical Academy of Mexico for work on typhus fever. Of the sum named, £1,000 will be awarded to the discoverer of the cause of typhus, or of a curative serum, and £500 to the investigators whose work is judged most useful in helping towards such discovery. The competition is international, but all essays must be written in Spanish. They can be received up to February 28, 1911.

The Herter lectures at the University and Bellevue Hospital Medical College will be given this year by Professor Otto Cohnheim, of the University of Heidelberg. The lectures begin on Monday, December 6, at 4 P.M., and continue daily throughout the week. The subject is "Enzymes and their Actions." Those interested are cordially invited to attend.

The fourth lecture in the series under the J. C. Campbell lecture fund was given on October 19, before the society of the Sigma Xi at Ohio State University, by Professor H. T. Ricketts, of the University of Chicago. The subject of the address was "The Transmission of Disease by Insects."

On the program of the meeting of the American Philosophical Society for November 5 is a paper on "The Correlation of the Gastric and Intestinal Digestive Processes and the Influence of Emotions upon them" (with X-ray illustrations of the movements of the food in the digestive organs), by Dr. W. B. Cannon, professor of physiology in Harvard University.

Professor Otto Folin, of Harvard University, has delivered a lecture before the Academy of Medicine, Cleveland, O., on "Ten Years' Progress in the Field of Metabolism."

The American ambassador presided at the opening meeting of the winter session of the London School of Tropical Medicine, on October 26, when Professor W. Osler, M.D., F.R.S., regius professor of medicine at Oxford University, made the address on "The Nation and the Tropics."

The Bradshaw lecture of the Royal College of Physicians of London, delivered on November 2 by Professor J. A. Lindsay, was on "Darwinism and Medicine." The FitzPatrick lectures by Sir T. Clifford Allbutt, on November 4 and 9, are on "Greek Medicine in Rome."

The *Journal* of the American Medical Association states that the dedication of the monument to the memory of Professor P. Tillaux took place in the amphitheater of anatomy of the hospitals of Paris on October 29. This monument was the last work of the sculptor Chaplain. It is in marble, and represents Tillaux standing, his right hand on a half-dissected cadaver, giving his lesson in anatomy. The monument stands in the garden of the amphitheater where Tillaux was director of anatomy before being appointed professor in the medical school.

UNIVERSITY AND EDUCATIONAL NEWS

Following the acceptance of the gift by Mr. W. C. Procter of $500,000 for the Graduate College of Princeton University, the trustees have chosen as its site the land added to the campus in 1905. This tract is a short distance to the southwest of the central campus. It contains 240 acres, sloping to the

southeast on contour lines similar to those of the older campus.

TEACHERS COLLEGE, Columbia University, will purchase, at a cost of about $200,000, a ten-acre tract of ground overlooking Van Cortlandt Park, near the terminus of the subway. One third of the ground, a natural plateau about forty feet above the level of the park, will be used as an athletic field for the Horace Mann School. The remainder, a finely wooded plateau, about fifty feet higher, will be used for dormitories and houses for instructors.

DR. DONALD J. COWLING was installed as president of Carlton College at Northfield, Minn., on October 18.

DR. WILLIAM ARNOLD SHANKLIN will be installed as president of Wesleyan University on November 12.

MR. STEWART J. LLOYD has been made adjunct professor of chemistry at the University of Alabama.

LEON H. PENNINGTON, A.B. (Michigan, '07), Ph.D. ('09), has been appointed instructor in botany in Northwestern University.

AT Wellesley College the following promotions have been made: Elizabeth Florette Fisher, B.S., from associate professor to professor of geology; Lincoln Ware Riddle, Ph.D., from instructor to associate professor of botany; Caroline Burling Thompson, Ph.D., from instructor to associate professor of zoology; Alice Robertson, Ph.D., from instructor to associate professor of zoology. With the reorganization of the department of physical education Amy Morris Homans, M.A., formerly director of the Boston Normal School of Gymnastics, becomes head of the department of hygiene and physical education. Miss Homans is joined in this work by Dr. Frederick Pratt, instructor in biology and hygiene, and Dr. Louis Collin, instructor in applied anatomy.

DISCUSSION AND CORRESPONDENCE

A REPLY TO DR. PERCIVAL LOWELL

TO THE EDITOR OF SCIENCE: In your issue of September 10, Dr. Percival Lowell alleges that I have made four mistakes in my "Introduction to Astronomy," and from these alleged mistakes as premises he draws the unique conclusion that the planetesimal hypothesis "will not work." Quite apart from the validity of the allegations, it is, to me, a novel idea in logic that errors made in trying to support a proposition become thereby "disproof of it." One might infer by this sort of reasoning that the errors of the class-room have long since destroyed all the principles of mathematics. The logic of the present case is all the more remarkable in that two of the four alleged mistakes do not occur in my discussion of the planetesimal hypothesis at all, while the two that do relate to it are really one, and it is not shown that even this one has any *critical* relations to the hypothesis.

The first point raised by Dr. Lowell is in reference to the greatest and least velocities which meteors moving in parabolic orbits can have relatively to the earth, and in this discussion, which appears eighty-three pages before I have mentioned the planetesimal hypothesis, I have made an error for which I offer no excuse. In fact, it was quite inexcusable because I had fully treated, four years earlier, in my "Celestial Mechanics" (chapter VII.), the question of the motion of an infinitesimal body relatively to that of two finite bodies describing circles, and the velocity of impact of meteors is only a special case under it. If Dr. Lowell had been as generous in citing this earlier and fuller treatment as in quoting my brief remarks in the "Introduction to Astronomy," he could have omitted a considerable part of his own paper in the *Astronomical Journal*, whose method does not differ in any essential way from my exposition of the question. In fact, it would have been necessary only to have determined the constant of integration of my equation (7), page 186. But I made a mistake, and this seems to fix a new principle in logic with a quantitative function: a mistake in expounding one proposition, if made within 83 pages of the discussion of another proposition, throws discredit on the latter.

If it were not for the new logic, Dr. Lowell's second indictment would have nothing to do

with the planetesimal hypothesis, for the alleged error occurs in a discussion of the Laplacian theory in connection with the ninth satellite of Saturn. In this, I have used only the universally accepted principle of dynamics that the moment of momentum of any mass about an axis can be changed only by a couple about the same axis. I can not accept the interpretation Dr. Lowell puts on my words, nor admit the correctness of his contention.

The statements which contain the third and fourth alleged errors do, indeed, appear in my discussion of the planetesimal hypothesis. They are quoted by Dr. Lowell, one as being "on page 480," and the other as being "from pages 478 to 481." They are, however, not only a part of the same discussion, but are in a single short paragraph on the same page (480). The third alleged error is in a formula occurring at the end of the fourth alleged erroneous statement, and gives the precise condition under which the conclusion reached is true. I suppose it is a part of the new logic to divide what is indivisible by the old logic, to invert the order, to give reference to the specific page of one, and to state simply that the other lies between certain pages; or, the last may be for rhetorical effect, as it avoids the repetition of a page-number, which might become monotonous if given more than once.

Not being as yet very familiar with the new logic, I will, with Dr. Lowell's permission, treat the statements in the order in which they occur in my book. The point in question is the effect of the collision of meteoric masses upon the dimensions of satellite orbits, particularly in the earlier stages of their development. By carefully omitting, in his last quotation, the sentences in which I have given the conditions under which my conclusions are true, he has made it appear that I have made categorical statements of universal application, and he has then found examples *outside of the conditions clearly specified* where my conclusions are not true. He then asserts that this is a "disproof" of the planetesimal hypothesis.

The associated alleged error is in the formula expressing the final conditions under which my conclusions are true. Dr. Lowell's friends will regret to learn that he has been overhasty in criticizing it, considering the weighty conclusion he has hung upon his criticism. In the first place he has not quoted it quite correctly, and in the second place he starts from an erroneous equation himself. Since the linear units are not specified, the elementary principle of homogeneity of units should have shown him that the right member of his first equation is incorrect. Its left member is also inexact, due apparently to an erroneous use of the integrals of the two-body problem. If we let μ represent the mass of the satellite, his first equation should have been the inequality

$$\sqrt{1+\frac{M+\mu}{R}}-\sqrt{\frac{M+\mu}{r}}>\sqrt{1+m}\sqrt{\frac{1-e}{R-r}}.$$

Developing and omitting the negligible terms of higher order, we get precisely the formula given in my book. Consequently I stand by the conclusions reached in my book on this subject when the conditions are satisfied under which I have clearly stated they are true.

Now of the planetesimal hypothesis itself, which is much more important in the present connection, Dr. Lowell appears really to have a very excellent opinion, barring its tag and signs of parentage. In his "Mars as the Abode of Life" (1908) he says, pp. 3 and 4:

> So far as thought may peer into the past, the epic of our solar system began with a great catastrophe. Two suns met. . . . It is not to be supposed that the two rovers actually struck, the chances being against so head-on an encounter; but the effect was as disastrous. Tides raised in each by the approach tore both to fragments, the ruptured visitant passing on and leaving a dismembered body behind in lieu of what had been the other. . . . Thus, what had been a sun was left alone, with its wreckage strewn about it. Masses large and small made up its outlying fragments, scattered through space in its vicinity, while a shattered nucleus did it for core.

On page 6 he says:

> Thus they [the meteorites] proclaim themselves clearly fragments of some greater body. To the

sometime dismemberment of this orb, from which disintegration our sun and planets were formed, the little solitary bits of rock thus mutely witness.

In the *Atlantic Monthly* for August, 1909, in an article entitled "The Revelation of Evolution," on page 177, after commenting on and dismissing the Laplacian theory, he says, in introducing more recent work:

Without attempting here a picture of what probably took place, let me sketch a line or two of its reconstruction as they have taken shape at midnight to one watcher of the stars.

And on the following page we read:

From the information afforded us by meteorites we turn to another discovery of recent date, the recognition of the spiral nebulæ. . . . Now, this spectrum [that of the spiral nebulæ] is just what they should show were they flocks of meteorites—and such they undoubtedly are. They give us, therefore, the second chapter of the evolutionary history. For, from their peculiar structure, we can infer what the process was that scattered the constituents of the once compact ball whose existence the meteorites attest. They consist of a central core from which two spiral coils unfold, the starting point of the one diametrically opposite the other. Now this is what would happen had the original mass been tidally disrupted by a passing tramp. Tides in its body would be raised toward and opposite the stranger, and these would scatter its parts outward; the motion due the tramp combining with the body's spin to produce the spiral coils we see. Just as in the meteorites we have found the substances from which our solar system rose, so in these nebulæ we see an evolution actually in process which may have been our own.

To those who have read the literature of the planetesimal hypothesis as it has come forth, stage by stage, during the past decade this will sound strangely familiar; and when reading Dr. Lowell's statements about the origin of meteorites, one can not help but recall Professor Chamberlin's article in the *Astrophysical Journal* eight years ago, "On the Possible Function of Disruptive Approach in the Formation of Meteorites, Comets and Nebulæ." But perhaps Dr. Lowell does not read the *Astrophysical Journal*, which is edited and published not far from the home of that "geologist out West"[1] who "astronomically . . . is unaware that what prompted his contention, the Planetesimal Hypothesis, is mathematically unsound." The Carnegie Institution, however, is not so far "out West" that it has forfeited its claim to "be treated with respect," and in its "Year Books" of 1902 to 1907 are full expositions covering every essential element that enters into the midnight reconstruction.

From these quotations it is clear that Dr. Lowell has a real affection for the main features of the planetesimal hypothesis, and if I had not been so unfortunate as to have utterly destroyed it (according to the new logic) by the blunder in my book 83 pages before I took the hypothesis up, he might almost have reconstructed it from his own recent writings. I am wondering whether in his forthcoming book on "The Evolution of Worlds"[2] he will not give additional proof of his affection for the planetesimal theory, though perhaps under some other name, or in some nameless form, more congenial to that mysterious "watcher of the stars" whose scientific theories, like Poe's visions of the raven, "have taken shape at midnight."

F. R. MOULTON

[1] *Atlantic Monthly*, August, 1909, p. 181, footnote: "Even as this essay stood between pen and print a geologist out west, in a long letter to *Science*, has repeated, in reference to the facts here set forth, the old attacks on Darwin for daring to synthesize the facts; though the geologic facts are from Sir Archibald Geikie, our own Dana and DeLapparent, who should certainly geologically be treated with respect. Astronomically he is unaware that what prompted his contention, the Planetesimal Hypothesis, is mathematically unsound."

[2] In the advance description of this book we read: "So important scientifically is the work of Professor Percival Lowell that the announcement of a new book by him might seem to belong rather in the list of technical works than in a catalogue of general reading. Professor Lowell, however, has the rare art of conveying important and new truths in language readily intelligible to the general reader. . . . His theme is the process by which a world comes into existence, the phases through which it passes. . . ."

THE DEVELOPMENT OF THE PLANETESIMAL HYPOTHESIS

WHEN, in 1906, the planetesimal hypothesis had reached a stage of development sufficient to warrant its introduction as a working hypothesis into text-books of geology and astronomy, it seemed to its authors worth while to draw up and place on their private files a memorandum of the several stages of cosmogonic study that had led up to the hypothesis in the form it had then taken. It was not assumed that the hypothesis had reached a final form, much less that it was in any sense then proven or that could approach proof until after a long period of trial and the closest scrutiny. On the contrary, they were then engaged in further efforts to test its working qualities and to add to its details or to modify them. It, however, seemed worth while at that stage to make note of preceding steps of progress while fresh in mind for future reference if occasion should require. Such occasion seems now to have arisen.

In the introduction to the memorandum, by way of qualifying the statements of the individual parts taken, it was noted that the mutual studies of the authors had grown up so gradually and informally, their conferences had been so frequent and so free, and their relations so intimate that it was difficult to set down with accuracy the precise parts contributed by each, or the aid rendered each to the other in working these out. The memorandum was intended to indicate merely the main individual lines of work and the leading stages of progress. A quite accurate and detailed history could be worked out, if it were worth while, from the note-books of advanced students of the University of Chicago from 1892 onward, as they were familiar with the status these studies had reached at the times their lecture notes were taken. Several of these students made computations or rendered other aid sufficient to call for notice in the papers published, among whom were A. W. Whitney, H. L. Clarke, J. P. Goode, H. F. Bain, S. Weidman, C. F. Tolman, Jr., N. M. Fenneman, C. E. Siebenthal, R. T. Chamberlin and W. H. Emmons.

In the synopsis below, the memorandum of March 12, 1906, is followed in the main, but the abbreviated phrases and references have been rounded out or recast to make them more specific and the whole brought down to date.

I. DESTRUCTION (IN THE MAIN)

Line of Approach and First Step.—To find out what effects on geological climates might be assignable to changes in the constitution of the atmosphere, Chamberlin, in the middle nineties of the recent century, attempted to test, by means of the molecular velocities involved after the method of Johnstone Stoney, the probable limits to the extent of the atmospheres in early geological stages, particularly those conditioned by the molten and gaseous states of the early earth as then commonly postulated.

These tests were found to throw doubt on the common belief in the enormous extent of hot vaporous atmospheres supposed to prevail during the gaseous and molten states of the earth. The test was then carried back to the earth-moon ring postulated by the Laplacian hypothesis where its application seemed fatal to the hypothesis. Moulton aided in his test by preparing tables of parabolic velocities for the earth at various heights above its surface and at different rates of rotation. Dr. A. W. Whitney made computations relative to molecular velocities under varying temperatures and pressures. The results were set forth in a paper read by Chamberlin at the Toronto meeting of the British Association for the Advancement of Science, August 20, 1897, and more fully in the *Journal of Geology*, October-November, 1897, pp. 653–683.

Second Step.—The conclusion that the nebulous matter of the supposed earth-moon ring could not remain in a true gaseous state, *i. e.*, with the molecules in active collisional relations to one another, under the conditions postulated for the earth-moon ring under the Laplacian hypothesis, led Chamberlin to consider the alternative conception of molecules or particles revolving in independent orbits in planetoidal fashion. Condensation from this state had previously been held, generally if not universally, to give rise to *retrograde*

rotations, whereas most of the rotations of the solar system are direct. Among the more convenient references showing the general acceptance of this view are the following: D. Kirkwood, *Am. Jour. Sci.*, XXXVIII., Nov., 1864, pp. 1–2; A. Hinricks, *Am. Jour. Sci.*, XXXVII., 1864, pp. 48–52; D. Trowbridge, *Am. Jour. Sci.*, XXXIX., 1865, pp. 25–43; A. Clerke, "History of Astronomy during the Nineteenth Century," 1893, p. 383; H. Faye, "Sur l'Origine du Monde," 1896, pp. 138–140, 164–171, 270–281; C. A. Young, "General Astronomy," 1899, pp. 568–572; Sir Robt. Ball, "The Earth's Beginning," 1902, pp. 324–347; A. Clerke, "Modern Cosmogonies," 1905, pp. 26–42. It was therefore clear that if this deduction were valid it was fatal to all hypotheses of the planetesimal type; indeed its supposed validity was probably the reason why such hypotheses had not been entertained. This apparently fatal bar was removed by Chamberlin, who pointed out that in the case of bodies moving in elliptical orbits about a common center, collision can only take place when some part of the *perihelion* section of the *outer* orbit coincides with some part of the *aphelion* section of the *inner* orbit, and that *at the point of collision* the body in the outer orbit moves faster than the body in the inner orbit, though on the average the body in the larger orbit moves slower than the one in the smaller orbit, which general fact was made the basis of the previous adverse reasoning. The way was thus opened for the construction of a tenable hypothesis on the orbital basis, including the form later called *planetesimal.* This germ of constructive work on lines previously regarded as untenable was briefly stated in the paper read before the British Association for the Advancement of Science, Toronto meeting, August 20, 1897, and published in the *Journal of Geology,* October–November, 1897, p. 669.

Third Step.—The tenability of construction on an alternative line being thus assured, the skepticism regarding the old nebular and meteoroidal hypotheses was more freely entertained and led to a search for other tests, particularly those resting on grounds other than molecular activity. The discrepancy between the slow rotation of the sun at present and the rotation it should have if it had contracted from a gaseous spheroid filling the orbit of Mercury and having the equatorial velocity necessary to shed the Mercurial ring as postulated by the Laplacian hypothesis, first came to Chamberlin's attention and led to a conference, with Moulton, late in 1899, out of which grew the more systematic inspection of the dynamics of the solar system in which the chief work was done by Moulton.

Fourth Step.—By restoring theoretically, in conformity with the laws of gases, the nebulous stages of the Laplacian hypothesis, comparisons of the several moments of momenta of the spheroid at these stages with the moments of momenta of the equivalent parts of the existing system were made by Moulton with results that seemed fatal to the Laplacian hypothesis and to all other hypotheses which had a similar dynamic basis.[1] Several other tests of a dynamical character equally adverse to the Laplacian hypothesis were also set forth in this paper.

Although the restorations of the solar spheroids at the various nebulous stages were made on the basis of the known laws of distribution of gases, with liberal margins of safety, uncertainty as to the full trustworthiness of the extension of the laws of gases to bodies of such tenuity and at such temperatures was unavoidable. To cover doubts arising from this source, independent tests were made by Chamberlin on the basis of the ratios of the masses to the moments of momenta of the spheroids and of the separated rings, respectively, using the masses and the moments of momenta of the present derived bodies, thus avoiding the application of the laws of gases; and the results were found to be equally adverse to the Laplacian hypothesis.[2]

[1] "An Attempt to Test the Nebular Hypothesis by an Appeal to the Laws of Dynamics," by F. R. Moulton, *Astrophysical Journal*, March, 1909, pp. 103–130.

[2] "An Attempt to Test the Nebular Hypothesis by the Relations of Masses and Momenta," by T. C. Chamberlin, *Jour. Geol.*, Vol. VIII., January–February, 1909, pp. 58–73.

II. CONSTRUCTIVE (IN THE MAIN)

The preceding work was chiefly destructive, but there were three notable exceptions: (1) The opening of the way to construction on planetoidal lines; (2) the determination of rather rigorous criteria that must be met in forming a tenable hypothesis, viz., *the conditions must be such as to give low mass, high moment of momentum and irregular distribution of matter to the outer part of the system, and high mass, low moment of momentum and sphericity to the central part;* and (3) the recognition that spiral nebulæ offered the greatest probability of meeting these criteria and of having at the same time a planetoidal organization.[3] A summation of the leading points made in the destructive work, together with a statement of the constructive criteria above named and of the grounds for giving precedence to spiral nebulæ in the search for an origin of the solar system, was published in SCIENCE, August 10, 1900, by Chamberlin and Moulton jointly.

Fifth Step.—Considerable futile work was done, largely by Chamberlin, in trying out the possibilities of collision between nebulous bodies as a mode of origin of spiral nebulæ, but no escape was found from the high probability, amounting almost to certainty, that the resulting orbits would be too eccentric to fit the case of the solar system in any instance that was likely to occur.

Sixth Step.—The effects of the differential attractions exerted by bodies on one another when they make close approaches were then studied by Chamberlin in the lines marked out by Roche, Maxwell and others, and found to be a promising field for hypothesis respecting the origin of meteorites, comets and nebulæ. This study included not merely the direct tidal effect on a passive body, following Roche, but also the projective effect developed in a body of enormous elasticity already under high pressure and affected by violent local explosions which were subject to intensification by the changes of gravity brought to bear on them by a passing body. It was shown that the contingency of close approach was much greater than that of collision, and that the results, (1) in the case of the disrupting of solid bodies, afforded a felicitous basis for explaining the erratic orbits of comets, the clustered fragments of the comet heads, and the angularity of the meteorites into which they are supposed to be finally dispersed; while (2) the explosive projections from suns under the influence of the passing body gave a reason for the two-armed feature of most spiral nebulæ—a neglected feature to which attention was specially called—for the spiral form, for the knots and haze, and at the same time offered a basis for inferring their dynamical state. These radical hypotheses were set forth in a paper entitled "On a Possible Function of Disruptive Approach in the Formation of Meteorites, Comets and Nebulæ," by T. C. Chamberlin, *Astrophys. Jour.*, Vol. XIV., July, 1901, pp. 17–40; also *Jour. Geol.*, Vol. IV., 1901, pp. 369–393.

Seventh Step.—With these conceptions of the origins and dynamical states of meteorites and spiral nebulæ as the bases of alternative hypotheses, a more critical study was made of the probabilities of origin of the solar system from *swarms* of meteorites of *heterogeneous* and *quasi-gaseous* organization, and, more radically, of the probabilities of the *origin of such swarms* either by concentration from a state of greater diffusion or by the dispersion of some previous body. Conditions favorable to the evolution of the solar system were not found, except when the meteoric organization took the planetesimal form.[4] Specifically, the conclusion reached was that the heterogeneous meteoritic state is "inherently moribund, passing into the gaseous state on the one hand, or into the planetesimal on the other, or, in the absence of assemblage, losing its constituents to existing suns and planets by capture one by one."[5]

[3] Chamberlin in *Journal of Geology*, VIII., January–February, 1900, pp. 72–73; Moulton, *Astrophysical Journal*, XI., March, 1900, p. 130.

[4] Chamberlin in Year Book No. 3, Carnegie Institution of Washington, 1904, pp. 195–208.

[5] *Ibid.*, p. 208.

Eighth Step.—Concurrently with these constructive attempts of Chamberlin with futile results except as based on planetoidal lines, Moulton attempted a critical review of all recorded cosmogonic hypotheses, but unforeseen conditions caused the temporary suspension of work and prevented a final treatment and publication of the assembled material.[6]

Ninth Step.—With (1) an open door for constructive work with nebulæ of planetoidal dynamics made available in 1897, with (2) the controlling criteria defined, and with (3) the limitations of tenable hypotheses narrowed by the futile work, the planetesimal hypothesis was gradually given shape and working form chiefly by Chamberlin in the absence of Moulton, as set forth in Year Book No. 3, Carnegie Institution, 1904, pp. 208–233; but this shaping of the hypothesis passed under the criticism of Moulton before publication. The spirit and purpose of this constructive work is thus stated, pp. 232–233:

> It has thus been my endeavor to develop the hypothesis into sufficient detail (1) to furnish a large number of points of contact with known phenomena and with recognized mechanical principles to facilitate testing its verity by those relations, if not now, at least in the early progress of investigation; (2) to furnish a basis for deducing the hypothetical stages of the earth that preceded its known history, and for drawing thence inferences as to the conditions of the interior which the earth inherited from the mode of its birth; and (3) to stimulate inquiry into the elements involved. In short, I have endeavored to give the hypothesis a working form under the conviction that so long as the complicated elements involved remain so imperfectly determined as at present its working value is its chief value.

Preliminary to this publication the essential features of the hypothesis had been discussed before several scientific societies and subjected to criticism. The hypothesis was also set forth by Moulton in a paper "On the Evolution of the Solar System," *Astrophys. Jour.*, October, 1905, pp. 165–181.

Later Steps.—The hypothesis was somewhat further elaborated and supplied with illustrations for text-book use by Chamberlin for the chapter on the Origin of the Earth in Chamberlin and Salisbury's "Geology," Vol. II., Chap. I., pp. 28–81, 1905, and by Moulton for his "Introduction to Astronomy," 1906, pp. 463–487.

Subsequent work in further testing, developing and applying the hypothesis has been in progress as set forth in Year Book No. 4, Carnegie Institution, 1905, pp. 171–173 (Chamberlin), and 186–190 (Moulton); Year Book No. 5, Carnegie Institution, 1906, pp. 165–172, and in later Year Books. More specifically and concretely, the continuation of investigation on lines growing out of the planetesimal hypothesis is shown by Publication No. 107, of the Carnegie Institution, entitled "The Tidal and Other Problems."

T. C. CHAMBERLIN
F. R. MOULTON

CHICAGO,
October 14, 1909

[6] Moulton in Year Book No. 3, Carnegie Institution, 1904, pp. 255–256.

AN ASSOCIATION OF AMERICAN CHEMICAL RESEARCH LABORATORIES

TO THE EDITOR OF SCIENCE: In connection with the second decennial celebration of Clark University, a special meeting was held on September 16 last "for the purpose of forming an Association of Chemical Research Laboratories, to systematically exchange chemicals urgently needed in research work." Many of your readers will doubtless be interested to know the outcome of that meeting.

Chemical research, especially organic research, in this country is greatly handicapped by the length of time it takes to import chemicals from Germany, when a need for them arises unexpectedly in course of an investigation. To quote a single opinion expressed at our September meeting, Professor Arthur Michael declared that his output of work, during the past twenty-five or thirty years, has been reduced fifty per cent. by this handicap.

Now, a chemical urgently needed in one laboratory is very often lying unused in some other laboratory. It would be gladly placed at the disposal of the investigator who hap-

pens to need it, if a definite system of communication and exchange were established between the laboratories.

Such a system will now be put in operation by the newly formed Association of American Chemical Research Laboratories, of which I have been elected secretary for the academic year 1909–10. A number of the more important chemical research laboratories, including those of Harvard University, the University of Chicago, the University of Illinois, Columbia University, the Massachusetts Institute of Technology, Brown University, the University of Toronto, and others, have already joined the association, and other laboratories are welcome to join at any time. Each laboratory desiring to join the association should send to the undersigned a copy of Kahlbaum's or some similar catalogue, with marks on the margins showing what chemicals, and roughly what quantities of them, are contained in its stock. If a preparation is needed by any member of the association, inquiry is sent to the secretary, who will return information as to where and in what quantities the chemical is to be found. Every member of the association is pledged to loan to any other member any chemical which he does not immediately need himself. On the other hand, a member borrowing a preparation is pledged to order it from abroad and to return it without undue delay to the laboratory from which it has been borrowed.

The warm approval with which the plan met when presented at the Clark University conference would seem to justify all hope for its complete success.

M. A. Rosanoff

Clark University,
Worcester, Mass.,
October 12, 1909

FAMILY RECORDS

To the Editor of Science: Last spring I asked, through Science, for volunteers from among American men of science to furnish records of certain characteristics of their families for three or more generations. The response was unexpectedly large and a valuable lot of data was acquired that is now being worked up. Much more data could, however, be used to advantage and so I make this second call for volunteers. Two sets of blanks will be furnished to each person desiring them, of which one may be retained for personal use. Information is asked concerning some 35 characteristics of each individual recorded so that the task of filling the blanks is not inconsiderable. It appears that in many families the data asked for can be obtained by taking a little trouble and the indications, so far, are that the trouble is well worth while.

It would be a great help if those who have quite or nearly filled out the "Family Records" that they received last spring should return them to me as soon as convenient.

C. B. Davenport

Cold Spring Harbor, N. Y.

SCIENTIFIC BOOKS

The Plankton of the Illinois River, 1894–1899. Part II. Constituent Organisms and their Seasonal Distribution. By C. A. Kofoid. Bull. Ill. State Lab. of Nat. Hist., Vol. VIII., Article I., 361 pp., 5 pl., May, 1908.

This is the second volume based on the plankton investigations made by Professor Kofoid on the Illinois River. It gives the results of quantitative, numerical and qualitative studies made on plankton material which was collected in the channel waters, chiefly at weekly intervals, during the years 1894 to 1899.

As a result of the commingling of organisms from various and diverse sources, the plankton of this river has a markedly composite character, no fewer than 528 forms being represented. Notwithstanding this large number of forms, it still does not show so great a diversity of organisms as marine plankton. Fresh-water plankton is characterized by the almost universal absence of larval forms, the exceptions being the glochidia of the Unionidæ and the larvæ of dipterous insects; by the smaller number of invertebrate groups represented; and by the smaller size of the component organisms. In spite of the smaller number of forms in this

river plankton, however, its quantity was larger than that which has been obtained from the upper strata of the Atlantic Ocean.

The phytoplankton consisted chiefly of algæ and the zooplankton of Protozoa, Rotifera and Entomostraca. Relatively the plants outnumbered the animals nearly five to one. For each of the Cladocera, there were 7 Copepoda, 95 Rotifera, 18,000 Protozoa and 86,000 plants. This large number of plants would furnish an abundant supply of food for the zooplankton.

By far the greater portion of the paper consists of a detailed discussion of the statistical data pertaining to the various constituent organisms, but space will permit the consideration of only the most important of the larger groups. Bacteriaceæ were found throughout the year, but they reached their maximum development in the winter from December to January. They sometimes became a serious menace to the fishing industry as they collected on the fyke nets in such masses that their weight and resistance to the current would break the nets.

The Myxophyceæ also contributed to the phytoplankton throughout the year. Quantitatively this group was not so important as some of the others, owing to the small size of its most numerous member, *Microcystis*. *Rivularia*, *Glœotrichia* and *Aphanizomenon*, which occur so generally in lakes, were not found in this fluviatile plankton. The Chlorophyceæ were well represented both in species and individuals and showed evidences of their adaptation to the whole range of temperature changes. The group as a whole exhibited maximum periods at approximately monthly intervals. Bacillariaceæ were found in every collection and their seasonal distribution was substantially repeated from year to year. The chief maxima were found in April-May and in November-December, with smaller maxima and minima intervening.

All the collections contained large numbers of Protozoa. The Mastigophora, which consisted chiefly of chlorophyll-bearing Protozoa, were found at all seasons of the year, but four fifths of them came between the first of April and the last of September, or during the season of growth for land flora.

While Rotifera were obtained at all seasons the number was uniformly low in winter. They showed great fluctuations at other seasons. There was an apparent tendency, however, for a vernal and an autumnal maximum. With three exceptions no maxima of any considerable amplitude were found when the temperature of the channel water was below 15.5° C.

The Entomostraca as a group were represented in all collections. The minimum number was found in mid-winter and the maximum for the year in April and May. During the remainder of the year, there was usually a series of recurrent maxima and minima which generally coincided with or approximated such periods in the other plankton organisms and often showed correlations in amplitude.

Cladocera were noted every month of the year, but they did not appear in ten of the collections. The minimum numbers were found during the period of minimum temperatures and the total varied more or less with the hydrographic changes. The Copepoda were, on an average, about five times as numerous as the Cladocera. They were perennial and had a major maximum in April-May with an occasional autumnal maximum of equal or greater proportions. By far the greater proportion of the Copepoda were young, 78 per cent. being nauplii of *Cyclops* and *Diaptomus*, and 13 per cent. immature *Cyclops*.

In the concluding chapter, Professor Kofoid states that one of the most obvious conclusions of his detailed study is that the plankton production was fundamentally rhythmic or periodic in character, viewed either in its constituent elements or as a whole. The exceptions to this rhythm were usually the adventitious forms. The cause of the periodicity was not clearly revealed. It was not correlated with the physical and chemical conditions of the water. The duration interval of the rhythms averaged approximately that of the lunar month, but showed considerable variations, as might naturally be expected, owing to the very large number of environmental factors involved.

Since the maxima of Rotifera and Entomostraca were coincident with or followed closely those of the chlorophyll-bearing organisms upon which they fed, the author reaches the conclusion that the factors which controlled the periodic growths in the food organisms would account for the rhythmic phenomena in the total plankton. If some observations made by Knauthe which seem to indicate that moonlight increases the photosynthetic activities of chlorophyllaceous organisms, and consequently their growth, be accepted, then Professor Kofoid thinks that this recurrent factor of the environment may account for the rhythmic growth of these organisms which results in the production of maxima each month at or near the time of full moon. It may be said, however, that the effect of moonlight on photosynthesis must receive further confirmation before it can be regarded as a factor of appreciable importance in the production of these phenomena.

These studies show that the Illinois River possesses an abundance of plankton material which will serve as food for the higher organisms, and this abundant supply of food material doubtless bears a very important relation to the large production of food fishes for which this stream is noted. It is also interesting to know that plankton work was recently resumed on this river after an interruption of ten years.[1]

C. Juday

Madison, Wis.

The Theory of Valency. By J. Newton Friend. London and New York, Longmans, Green & Co. Pp. xiv + 180; crown 8vo, cloth. Price, $1.60.

This little volume is the latest addition to the series of "Text-books of Physical Chemistry" edited by Sir William Ramsay. The first thirteen pages are of the nature of an historical introduction. This is followed by thirty-eight pages devoted to the theory of valency, valency and the periodic law, the valency of carbon, and Thiele's theory. Ten further chapters covering sixty-nine pages are then devoted to a somewhat detailed discussion of the valency of the elements contained in each of the groups of the periodic system. Finally, forty-three pages are taken up in the consideration of Werner's theory, electrochemical theories, and the physical cause and nature of valency. The chapters on the valency of the elements of the various groups of the periodic system are rather tedious reading, and frequently lack completeness and adequacy. Many of the statements and explanations they contain would certainly be challenged by chemists. But it must be remembered that the subject of valency has ever been warmly debated, and it is hardly to be expected that a brief résumé of it would meet general approbation. In the study of the compounds of carbon and also in the investigation and correlation of many other compounds, particularly the simpler ones, the theory of valency has been of inestimable value, and the book does give the reader this impression correctly. On the other hand, in the discussion of variable valency, and the matter of partial valencies, the author has not always been clear. The reader is here left with the idea that these portions of the subject are rather more hazy and indefinite than they actually are. The introduction and the discussion of the various theories of valency form by far the best portions of the book. It is somewhat peculiar that the theory of valency should have been chosen as the subject of a volume of a series of books on physical chemistry, for valency has always been considered as belonging to chemistry proper. As Dr. Friend's book is the only attempt of an exhaustive, systematic treatment of the subject of valency, it will no doubt be useful to mature readers who can read it critically. The various references given, though they are far from complete, will nevertheless serve very well to introduce students to the literature of the subject.

The print, paper and binding of the book are excellent, these features being similar to those of the other volumes of the series.

Louis Kahlenberg

[1] Science, Vol. XXX., p. 55.

THE MECHANICS OF BIOLOGY

WE Americans are often pointed out by the English and German and French as a people who do things in a hurry. Sometimes we are admired for it: other times otherwise. Well, we must not be too puffed up in the one case, nor, in the other, feel too solitary in our guilt. Two scientific books of much interest that have appeared here in Paris in the current fortnight are the stimulus to this sage reflection.

Last year a newspaper critic began an otherwise kindly review of a recent book by an acid reference to college professors who give a new course one year and make it into a book in the next. It is true that the particular book under review was the outcome of a college course, but President Jordan and I had given that course, with annual revision, for ten years, and before that it had already been given for five years by Dr. Jordan alone or with other colloboration. Fifteen years of ripening would seem to be a decent period —even for California fruit!

The authors of the two new French books I have referred to are at this very time, and for the first time, giving the lecture courses on which their books are based. This is at least literally true of Felix Le Dantec's "La Crise du Transformisme" (Alcan), and I strongly suspect it to be true of Georges Bohn's "La Naissance de l'Intelligence" (Flammarion). Le Dantec's book is composed of the November and December lectures in his still continuing Sorbonne course, while Bohn's course, just beginning, starts off much like his book. In his case, however, it may be fairer to look on the book as the precursor of the course.

In both cases the men are very competent to lecture or write on their respective subjects and both the books and the courses are fascinating contributions to present-moment biological discussion. Each man is an active exponent of a very advanced point of view in his field of special interest, Le Dantec advocating a rigorously mechanical explanation of vital phenomena in general and Bohn a consistently mechanical theory of animal behavior.

The impulse for Le Dantec's writing and the suggestion for his title lie in the swift growth to almost dominating position among species-forming explanations of De Vries's mutation theory. He attacks this theory with all the acuteness and vigor of his logically trained and argumentative mind. If he could only bring to its aid an equal strength of personal observation and experiment he would be an easily triumphant antagonist. But Le Dantec is more prolific of syllogisms than of original observations; is more at home in his lecture room or at his writing desk than in his research laboratory or in the field. And his argument is too often a refinement of logic or a development of terminology rather than a convincing enumeration of facts that carry their own irrefutable conclusion. One can fight for chemism in biology with metaphysic just as as one has long fought against it with the same old nicked and blunted weapon. And in either case the champion has a sorry tool.

Dr. Bohn's book is of very different type. It is the direct contrast in manner. It is judicial rather than lawyer-like, although the author has his convictions. He suspects all explanations too elaborate, but also those too simple. He deplores too much theory, calling for more facts. He analyzes and criticizes, weighs and estimates, and then seeks the simplest way out.

Bohn finds mechanical reflexes, vital rhythms and "differential sensibility" sufficient to account for the behavior of that great mass of the animal kingdom from the Protozoa up to the Crustaceans and insects. In these, with their special development of sense organs, especially eyes, behavior begins to take on its first phase of psychism—by this word being meant no dualistic conception of psyche and body but simply a certain degree of mentality or complicated functioning of nervous system, a behavior based on the association of sensations in addition to the tropismic responses. Finally, with the advent of brained animals, the vertebrates, comes the first intelligence, a dominating of the sensation associations over the mechanical reflexes, the tropisms.

Bohn would do away with the word instinct; and finalism is for him an explanation that comes into play only after a first appeal to other more mechanical inherent causes. "For Jennings," he says, "selection would be effected among the various movements of trial, and the final result would be a tropism. For us, the tropism, as Loeb has said, is something inherent, and it would be one of the elements on which selection would be exercised." Thus for Bohn the psychic evolution of animals would result, in some sort, from the struggle which occurs among the old survivals of the past (as tropisms and the phenomena of differential sensibility), and the new acquisitions (fruit of associative memory). This is made only painfully, and to a certain degree, by *"coups de revolutions."*

Finally Bohn believes that we are sufficiently advanced in our study of animal behavior to be able to enunciate certain laws, not only for the tropisms and differential sensibility—"a conception which for the first time appears in a book of animal behavior" —but also for the associative phenomena. He holds that animal psychology is now no more open to the criticism that its "explanations," such as tropisms, differential sensibility, associations of sensations, etc., are simply labels and terminology and do not really explain the animal mechanism in its behavior, than the other sciences whose more familiar terminology, as "gravitation," "atoms," etc., seem, but in reality only *seem,* to be so truly explanations.

When Newton discovered the laws of universal gravitation, he had to confess that he had no idea as to the *cause* of this phenomenon. Is his merit less great for that? Have not his ideas, although incomplete, permitted us to build a great scientific structure that compels all our admiration, although we may be to-day quite as little advanced as to the subject of the nature of gravitation as was Newton in 1687 or Epicurus three hundred years before Christ? Now in the domain of zoological psychology, the scholars of the new school inaugurated by Jacques Loeb seek to imitate Newton in the domain of astronomy; they analyze the phenomena and establish their laws. . . . As said recently by my regretted master Giard: "The analysis which is necessary to let us master the phenomena of life furnishes us a surer base than that which tends directly to explain these phenomena."

Vernon L. Kellogg

Paris,
April

NOTES ON ENTOMOLOGY

The report[1] of M. Roubaud, who spent a year and a half in the Congo region as a member of a commission to study sleeping sickness, is before us. It goes, in much detail, into the habits and habitats of *Glossina palpalis,* the particular species of tsetse flies which is concerned in the spread of this dread disease. Agreeable to the general rule he finds that the flies are very local, rarely going more than 300 yards, but may be carried by air currents and storms to greater distances. They bite only during the daytime, and feed on a great variety of animals. There is a long account of the larva, and of its curious posterior lobes, which apparently represent the posterior spiracles. The fly deposits the full-grown larva on the ground, which crawls into the soil and there pupates. The author details a number of experiments on the effects of different temperatures on the pupæ. Species of *Bembex,* a spider (*Dolomedes*), a beetle (*Cicindela*) and ants are among the natural enemies of the *Glossina.*

A large part of the work is taken up with a study of the Trypanosomes, and five of the plates illustrate them. A long bibliography is appended to the article.

The new parts of Wytsman's "Genera Insectorum" are as follows: Fasicle 76 is by J. J. Kieffer on the small Hymenoptera of the family Bethylidæ; 30 pp., 3 pls. He considers that they are most closely related to the Scoliidæ. Fasc. 77, by the same author, treats of the small family Stephanidæ; 10 pp., 1 pl. He adopts the classification of Ender-

[1] "La Glossina palpalis; sa biologie, son rôle dans l'étiologie des Trypanosomiases," Rapport Mission d'études de la Maladie du sommeil au Congo Français (1906–1908), pp. 383–652, 8 pls., 4to, 1909, Paris, by E. Roubaud.

lein. Fascicle 78 catalogues the beetles of the Group Languriinæ; W. W. Fowler is author; 45 pp., 3 colored plates. There is very little original matter. Fasc. 79, reviewing the Ortalid flies of the subfamily Pyrgotinæ, is by F. Hendel; 33 pp., 1 colored plate. This author, as usual, gives a very satisfactory account. Fasc. 80 is on the Scelionidæ, a family of minute Hymenoptera, by C. T. Brues; 59 pp., 2 pls. Many of the species are from the United States. An appendix includes the European species recently described by Kieffer. Fasc. 81 is by Dr. K. W. von Dalla Torre on the Anoplura, or lice; 22 pp., 1 plate; a brief treatment following the arrangement of Enderlein. Fasc. 82[a] is an elaborate treatise on the popular group of beetles—the Cicindelidæ, by W. Horn; 104 pp., 4 plates and a map of geographical distribution. Fasc. 83, Carabidæ, subfamily Omophroninæ, by E. Rousseau, 5 pp., 1 plate; fascicles 84, 85, 86 are by the same author on small groups of the Carabidæ. Fasc. 87 is on the "white flies—Aleyrodidæ," by A. L. Quaintance, 11 pp., 2 pls. Fasc. 88, on the beetles of the subfamily Erotylinæ, by Paul Kunht; 139 pp., 4 colored plates, appears to be very well prepared. Fasc. 89, 91, 92 are by A. Bovie on groups of weevils; Læmosaccinæ, 6 pp., 1 pl.; Belinæ, 13 pp., 1 pl.; Gymnetrinæ, 22 pp., 2 pls., 1 of which illustrates the life history. Fasc. 90, concerning grasshoppers of the subfamily Pyrgomorphinæ, is by I. Bolivar; 58 pp., 1 plate. It is a good treatment of a group well known to the author.

THE fourth volume of the Cambridge Natural History has at last been issued. It contains the accounts of the Crustacea and the Arachnida. The Arachnida is mostly by Mr. Cecil Warburton. The treatment is not very detailed, and in some parts, as the pseudoscorpions, much out of date. The chapter on mites is entirely too short, some large families, as the Hydrachnidæ, being disposed of in four or five lines. In general it is fairly accurate, but so much interesting matter has been omitted that the reader will gain only a slight idea of the enchanting world of arachnids.

THE new entomological parts of "Die Süsswasserfauna Deutschland's" include Hefte 3 and 4 on the Coleoptera, by E. Reitter, Heft 7 on the Collembola, Neuroptera Hymenoptera and Rhynchota, by R. and H. Heymons and Th. Kuhlgatz, and Heft 12 on the Araneæ, Acarina and Tardigrada, by F. Dahl, F. Koenike and A. Brauer.

The coleopterous part deals mostly with the Dytiscidæ, Hydrophilidæ and part of the Staphylinidæ. The part on Collembola is mostly on the genus *Smynthurus;* that on Neuroptera treats the genera *Sialis, Osmylus* and *Sisyra.* The Hymenoptera include species in the Ichneumonidæ, Braconidæ and Chalcidæ. The Rhynchota by Kuhlgatz is rather more complete than the other parts, with full descriptions of each species. The part on *Corixa* will be of value to the American hemipterist. Heft 12 on the Arachnida is almost wholly occupied by the water-mites, Hydrachnidæ, and is very fully illustrated.

ANOTHER part of the Catalogue of the Diptera of the world by Dr. C. Kertész is now before us.[2] This part contains the Bombylidæ, Therevidæ and Scenopinidæ. For this latter family Dr. Kertész has adopted the name Omphralidæ. The Bombylidæ include 1,696 species in 84 genera, the Therevidæ include 270 species in 16 genera, and the Scenopinidæ have but 28 species in 4 genera. *Conophorus* is used for *Ploas,* and *Argyramœba* for *Spogostylum* of the Aldrich catalogue. Especially commendable is the brief and logical form of his references.

A MONOGRAPH of *Myrmecophila,* a curious genus of crickets, is the theme of Fritz Schimmer.[3] A considerable part is devoted to the ethology and distribution of the genus, and especially to its relations with certain ants. The morphology and anatomy occupies the bulk of the paper, while in the systematic part are the descriptions of the eleven species, five of which occur in the United States.

[2] "Catalogus Dipterorum hucusque descriptorum," Vol. V., Budapest, 1909, 200 pp.

[3] "Beitrag zu einer Monographie der Gyrllodengattung Myrmecophila Latr.," *Zeitschr. wissenschf. Zool.,* Vol. 93, pp. 409–534, 3 pls., many text figs., 1909.

H. Schouteden has published another fascicle of his work on the Hemiptera of the Congo.[4] A list is given of all the species now known from that region, nearly 300 in all. The plates illustrate the new species.

Nathan Banks

SPECIAL ARTICLES

THE POSSIBLE EFFECT OF CEMENT DUST ON PLANTS

A short time ago my attention was called to an extraordinarily abundant deposit of light gray dust on all sorts of exposed surfaces out of doors in one of the valleys not far from San Francisco. This dust was declared to come from the manufactory of Portland cement owned and operated by the Cowell Lime & Cement Co., near Concord, California. Unfortunately the manufacturing plant was shut down during the time in which both of my visits fell, so I did not myself see that the dust came from those works and only from there. I have, however, no reason to doubt its source, the attorney, manager and other officials of the Cowell Company admitting that they lose much cement as dust.

The light gray dust forms, where reasonably undisturbed, a film of increasing thickness over everything out of doors. This film adheres to some surfaces much more closely than to others, according to the smoothness, hairiness, stickiness, moistness of the surface. It could not be entirely blown off any surface which I saw, but the rain which fell in the interval between my two visits washed it off some surfaces, but not by any means all. Where the dust fell on undisturbed soil it could be readily recognized because of its color and shade: it is a light gray, whereas the soil is brown. Although the roads are lighter in color than the fields, since they are partly macadamized with a light gray stone, they too are darker than the dust. The origin of the dust is, therefore, clearly not entirely from the roads or fields.

In composition the dust presents some interesting characters under the microscope. It is evidently composed of fine particles of at least three different sorts. One of these is translucent crystalline fragments, fairly numerous. Another sort, less numerous, consists of somewhat larger opaque and fairly rounded particles. By far the largest number, however, are minute granular particles which cohere in irregular masses, often of considerable size. The masses of coherent granular particles enclose and in a way bind together the particles of other sorts. The granular material readily dissolves, with effervescence, in hydrochloric acid, even dilute, but the other particles remain on the slide, under the microscope, undissolved. Acetic acid similarly affects the dust when applied to small quantities on the slide under the microscope. From this it is evident that the dust consists largely of some readily decomposed carbonate.

This dust more or less completely covers the foliage of the native and cultivated plants in a considerable area, extending, as I observed, to a distance of over six miles from the cement works. It is carried on the winds and, as is so common in this part of California, the winds prevail in very definite directions according to the season of the year. In consequence, the dust goes in one direction mainly during the summer, and leaves the remainder of the valley free. It is more abundant on the windward than the leeward side of scattered trees, of orchards, etc. It covers the upper surface of many leaves, such as oak, willow, grape, prune, plum, quince; but such glossy leaves as peach, lemon, orange do not hold it against a breeze. It adheres also to the under side of many leaves, especially if the under side is less smooth than the upper. On fruits it is also evident, especially on dark or dark-skinned sorts, and it can not be removed from them without also rubbing off the bloom; it will not simply drop off if they are dipped or washed in water.

The market value of property has naturally been influenced by this excess of dust; the salability of land within the affected district being greatly decreased, and the market for otherwise fine table grapes covered by a deposit of grit is altogether a limited one.

On the other hand, it may be questioned

[4] *Ann. Musee du Congo Belge, Zool.*, Ser. III., Sec. II., Tome I., fasc. 1, pp. 88, 2 col. plates, 1909.

how great or even what may be the injury to vegetation. Bearing in mind that leaves are the parts of the more highly developed plants in which food is made under the influence of light, and through which that exchange of gases takes place which corresponds with the more mechanical part of the process of respiration in our own bodies, we see at once that these functions of leaves may be interfered with by dust. The exchanges of gases in food-manufacture and in respiration take place mainly through the openings, known as stomata, in the epidermis of leaves. If these openings are stopped or are closely covered, obviously the passage of gases through them will be correspondingly more difficult, slower and less adequate. This will be possible, however, only if the particles of dust correspond in shape, size and position to the stomata, or are so compacted on the surface of the leaves as to cover them. Examination shows that some of the particles are small enough to clog the stomata and that they do so on the leaves of oak (*Quercus lobata*), fruit-trees and grape-vines. The coarser particles form more or less extensive crusts, thus covering over the stomata. Although naturally most of the dust settles on the upper side of the leaves, the lower side does not entirely escape the clogging or crusting over of its pores. But on neither the upper nor the lower surface is the covering of dust so thick and opaque as greatly to interfere with the passage of light to the inner tissues of the leaves.

The effect, then, of an accumulation of dust on the surfaces of leaves constitutes mainly a mechanical interference with the proper exchange of those gases concerned in respiration and in food-manufacture in plants. There is no evidence that the dust on these leaves has exercised any corrosive or otherwise poisonous influence on the tissues, and so far as my preliminary tests indicate, there is no evidence of the presence of injurious substances in the dust. The effect of the dust is mainly, if not wholly, mechanical. But, interfering with the supply of food-materials and with the proper aeration of the plant-body, it must be more or less injurious.

Furthermore, whatever the effect of the dust may be on leaves already grown and developed, it is certain to be greater on young and growing leaves. The cement plant in question has been in operation only a few months, since the season's foliage was developed. The effect on young parts is not known. It may be anticipated, however, that the *setting* of this material on the rough or hairy surfaces of young and growing leaves would not only interfere with the exchange of gases above mentioned and absolutely necessary to the health of plants, but would offer a mechanical hindrance to growth which would lead to distortions more or less serious.

Perhaps it will be objected that what I have said is not probable, in the light of experience elsewhere. For example, Haselhoff and Lindau express the opinion that cement dust does no harm to vegetation:[1] but they speak of the rains which wash off the foliage at frequent intervals during the German summer. In this part of California, on the other hand, conditions are quite different. There is practically no rain after the leaves of deciduous plants have developed, although there may have been abundant rain before then. The leaves are not washed off frequently; usually they are not washed off at all throughout the season. In this part of California there are frequent summer fogs which give very valuable moisture to vegetation.[2] These fogs would affect ordinary dust very little, if at all, but they would tend to *set* dust containing or largely composed of cement. In dry weather cement dust will tend to blow away, especially in high wind, but it will be held more or less firmly, in spite of wind, on leaves roughened by hairs or made sticky by the wounds of aphids. Any moisture, whether from the plants themselves or from the air, which does not come with sufficient force to *wash*, will tend to fix the dust, forming a more or less permanent crust. Indeed, the rain which fell with considerable force on one occasion between my two visits removed far less dust from the surface of

[1] Haselhoff & Lindau, "Die Beschädigung der Vegetation durch Rauch," Leipzig, 1903.

[2] See a forthcoming paper by me in *The Plant World* on the botanical conditions of this region.

plants than I had expected. The leaves of grape were fairly cleaned, but the fruit was not, and the effect on the leaves of plum, prune and oak was slight: the dust was on them in quantity. This rain, furthermore, came unusually early.

The climatic conditions here being so different from those elsewhere, I feel compelled to expect the results which I have indicated, unless the operation of the cement manufactory is so modified as to check the discharge of dust in quantity.

GEORGE J. PEIRCE

STANFORD UNIVERSITY, CAL.,
October 1, 1909

THE ALGÆ OF THE ITHACA MARSHES

INVESTIGATIONS on the fauna and flora of the marshes of the upper Cayuga Lake Basin during the past summer were continued at the Biological Field Station of Cornell University. Various studies were in progress. The writer undertook the study of the algæ. His investigations were made in connection with the work of Dr. J. G. Needham, and were directed toward the solution of the problem of the algal food supply of herbivorous aquatic animals that are used as food by fishes. No local data being available, a preliminary study of the algæ of the marshes was undertaken. With little variety of conditions, a great number of species was not to be expected; however, nearly all the genera of the commoner fresh-water algæ were represented, and perhaps a more thorough search would supply the missing ones. Over seventy genera were found, but the species were not all carefully worked out, owing to the unsatisfactory state of their literature. Material for future work on them has been preserved and will be worked over later.

The genus *Chætophora* is especially abundant in this region, and is represented by four species, three of which, *C. elegans*, *C. incrassata* and *C. pisiformis*, are very common. The dominance of this genus, and the fact that it is used extensively as food by aquatic animals that have importance as food for fishes, lead us to expect that it will be of some economic value and a special study of its habitat and capabilities of increase will be made in the future. The study of the optimum conditions for the development of several species of *Spirogyra*, *Mougeotia* and *Chætophora* was undertaken in order to facilitate the cultivation of these algæ, should they prove of economic importance. The results from these experiments, and from observations carried on in nature, lead us to believe that such forms might with proper facilities be raised on a large scale with good results; perhaps in such quantities as Dr. Needham's previous studies of artificially reared may-flies indicate may be demanded.

A beginning was also made in the study of the periodicity of the marsh algæ. It is hoped that facilities may be provided in the future for carrying on observations continuously for several years, as this seems to be the only way in which exact information concerning the ecology of the algæ can be obtained.

An interesting Phycomycete, parasitic on *Volvox globator*, was discovered during August, and this fungus will be described after further work has been done on its life history.

H. A. ANDERSON

THE MOLECULAR CONSTITUTION OF SOLIDS[1]

ACCORDING to the author, it is supposed and generally so stated, owing to complex movements and forces supposed to be present in solid bodies, there must be special difficulties to which it is due that the molecular thermodynamics and kinetics of solids can not be fully accounted for on the same basis as those of the gaseous bodies.

The present paper is calculated to show that the supposed difficulties are largely imaginary and that there are a notable number of solid and liquid substances, for which, according to the calculations and tables presented by the author, no essential difference exists regarding the mode and kinetic energy of the motion of their molecules as compared with those of gaseous bodies.

[1] Abstract of paper presented at the regular meeting of the Chicago Academy of Sciences, July 27, 1909.

In support of this, it is shown that the total heat energy at the melting point of metals in which the molecule probably consists of one or but few atoms can be found by doubling the latent heat of melting ($2l$) while the total heat energy of the liquid at the same point can be found by trebling the latent heat of melting ($3l$).

The author further shows that the amount of heat energy of a solid body thus calculated is equivalent to the total kinetic energy ($Mv^2/2$) of the molecules, calculated from the molecular velocity of the body, which velocity is determined in the same manner as is done in case of gaseous bodies in accordance with the kinetic gas theory.

As another proof of the author's assertions it is shown that the heat energy of many solid bodies calculated by multiplying the absolute temperature degrees of the melting point with an amended specific heat (Ts) is found to be practically identical with the energy quantities ($2l$) and ($Mv^2/2$) found as before stated.

Tables are submitted illustrating these conditions for mercury, silver, cadmium, tin, bismuth, potassium and platinum.

It is also shown in another table that chemical combinations such as water, saltpeter and chloral-hydrate follow the same rule if the splitting of their molecule at melting is duly considered.

To further establish the identity of principles of the kinetics of solids and gases a third table demonstrates that the interior energies of the permanent gases can be calculated with correct results on the basis of molecular velocities deducted from the latent heat of melting of solids.

As another corollary an original experiment is quoted according to which a drop of water is suspended in a liquid of equal specific gravity below its freezing-point when the globular form of the drop at once changes into an ellipsoidal form as soon as it freezes, showing that the abstraction of the latent heat of melting is accompanied by a great loss of energy in the perpendicular direction.

Some of the principal results of these investigations may, according to the author's summary, be itemized as follows:

1. The absolute zero of temperature —273° Cels. as derived from the kinetic conditions of gases may be derived from the kinetic conditions (molecular movements) of solids by identical processes of reasoning and calculation.

2. In the case of many solid elements, as well as also for many combinations of simple constitution, their total internal heat energy is chiefly kinetic energy approximately expressible by the product of their corrected specific heat with the absolute temperature (Ts_1).

3. The heat energy of such solid elements at their melting-points may likewise be expressed approximately by doubling their latent heat of melting ($2l$) and in the case of chemical combinations in which the molecule splits during the melting by $1l$. The total heat energy of the liquid body at its melting-point being three times its actual latent of melting ($3l$).

4. The molecular velocities of solids may be calculated from the same principles on which the kinetic theory of permanent gases is based.

5. The total kinetic energy of a body calculated according to these velocities is approximately the same as that derived from the latent heat of melting and also the same as that derived from the corrected specific heat multiplied with the absolute temperature.

6. The three different arithmetical expressions for the kinetic energy of a solid body at its melting-point, viz., Ts $2l$ and $Mv^2/2$, every one of which is derived from different experimental data and by different processes of reasoning give approximately identical results, thereby making all conditions of matter amenable to the same general kinetic principles, at least with respect to the substances under consideration in this treatise.

7. The molecular constitution of solid bodies is not essentially different, and in some cases apparently even less complex, than that of gaseous bodies, so that the translatory

energy of elastic spheres alone may suffice to account for their kinetic conditions in many respects.

J. E. SIEBEL

CHICAGO, ILL.

SOCIETIES AND ACADEMIES

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

THE 434th regular meeting of the society was held October 12, 1909, in the West Hall of the University Building, George Washington University, with President Fewkes in the chair.

The paper of the evening was by Dr. Ales Hrdlicka, whose subject was "The Anthropology of Egypt in the Light of Recent Observations." This dealt mainly with the results of Dr. Hrdlicka's expedition to Egypt, carried out during the first part of the current year under the auspices of the Metropolitan Museum of Art and the National Museum. The expedition brought, besides other results, very important additions to the skeletal collection in the National Museum.

The speaker, after pointing out the importance to anthropology of studies on the Egyptians, and mentioning the important work that has been and is being done in Egyptian research and exploration by American men of science, particularly Breasted, Reisner, Lythgoe and Davis, proceeded to discuss the results of recent investigations on well identified skeletal remains from that country, ranging from the earliest to the latest periods, and also the results of his examinations of the living remnants of the Egyptians.

The principal facts brought out were as follows:

Contrary to the hitherto prevailing opinion, there were, in the course of time, marked changes in the physique, particularly the form of the skull, of the Egyptians, the ancient crania being, on the average, decidedly longer and narrower than those of the later periods.

The Egyptians originated, in all probability, from more than one stream of anthropologically related people, the principal elements being Libyan and Puntite or Arabian.

Negro admixture was very small up to the time of the empire. A more noticeable addition consisted of a brachycephalic strain coming probably from Asia Minor. This is traceable from the earliest times and became important during the Greek and Roman occupation.

The Egyptians were light to medium brown in color, usually with black, straight to slightly curly hair, a moderate stature and muscular development. They approached closely in all their important features the north Africans and southwestern Asiatics and with these the European dolichocephalic whites.

At the present time the ancient Egyptians may be considered as practically extinct or rather obliterated. The actual population of the country is an amalgamation of the original inhabitants with the Arabs, Negroes and many elements from the northwest, north and northeast of the Nile Valley.

In certain localities traces of the old Egyptians still can be recognized. This seems to be principally the case in the great oasis. A series of 155 natives of this oasis were closely studied, also photographed. The data are being prepared for publication.

The paper was discussed by Professor Holmes, Dr. Casanowicz, Dr. Folkmar, Dr. Hough, Dr. Fewkes and others.

JOHN R. SWANTON,
Secretary

THE AMERICAN CHEMICAL SOCIETY. NEW YORK SECTION

THE first regular meeting of the session of 1909–10 was held at the Chemists Club on October 8.

Dr. Morris Loeb, in taking the chair, made a short address. He spoke of the plans of the section for the approaching session and especially commented upon the desirability of a chemical museum, expressing the hope that it might be housed together with the society library in the new quarters of the Chemists' Club.

Dr. A. P. Hallock gave a report of the general meeting of the society at Detroit, calling attention to the hospitality and very enjoyable entertainment offered by the Detroit Section.

Professor M. A. Rosanoff, of Clark University, read a paper by C. W. Easley and himself "On the Partial Vapor Pressures of Binary Mixtures." This paper is published in full in the current number of the *Journal of the American Chemical Society*.

Professor H. C. Sherman presented "A Source of Error in the Examination of Foods for Salicylic Acid."

The members present were invited to attend a special meeting of the Chemists' Club held after the adjournment of the meeting of the section. At this meeting the plans of the building committee for a larger and more adequate club house were adopted, insuring a home for the chemists of New York unexcelled in this country or probably abroad.

C. M. JOYCE,
Secretary

SCIENCE

FRIDAY, NOVEMBER 12, 1909

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE TEACHING OF ENGLISH IN A SCIENTIFIC SCHOOL

THE teacher of English in a scientific school faces in many ways a special problem. In a place where exact sciences are fundamental, he teaches an art which must often appeal to standards of taste. He finds always among his pupils a number who are at the start unsympathetic. Yet his subject is undoubtedly important. Aside from its practical value in training men in bearing and address, English composition may be made the basis of logical cultivation of the thinking powers, and the means of awakening in the mind the love of broader scholarship. On these accounts, if those interested in scientific education ask themselves how the time devoted to teaching English in scientific courses may best be employed, they are attacking a question by no means unimportant. In an attempt to throw some light on this question the present paper undertakes to deal with the broader aspects of the work in English composition as the writer has observed it during the last eight or nine years at the Massachusetts Institute of Technology.

Undergraduate instruction at the Institute of Technology is divided, as may be known, among thirteen prescribed courses of scientific and engineering studies, each of four years' duration. Without attempting to be precise, it may be stated roughly that the first two years are given up to studies which are regarded partly, or even mainly, as a means of general education. These subjects range from mechanical drawing, through elementary physics and chemistry, to history and economics. Some of them, like history, are purely educa-

tional; others, like drawing, have a distinct bearing on later professional work, but still are taught in the theoretical spirit, and with the purpose of developing power. To the latter class may be said to belong the subject of English composition. It is intended to furnish a tool for business and professional life; but at the same time it should serve to broaden the student's interests, to stimulate his power of observation, and to make him more alive to his inner mental process and better able to control it.

The time devoted to this subject is confined to two terms of fifteen weeks each during the first year of the four-year course. In the first term there are two class-room hours, and two hours of preparation each week. In the second term only half this time is allowed, and the division between class-room hours and preparation is left somewhat to the option of the instructor. When theme work is being assigned it is usual to consider two hours—the preparation period for the week—sufficient for the production of a theme of about three hundred words.

The work of instruction is carried on during the present year by a teaching force of eight persons. No detailed account of class-room methods is here intended, or would, indeed, be possible. The work has always been treated, by those responsible for its control, with a breadth and liberality which leave all possible scope for individual ingenuity in the teacher and for the adoption of new methods. To the writer, accustomed for some years to this large measure of freedom, it is inconceivable that work so dependent for its success on inspiration could be accomplished under any other system. At all events it is the happy privilege of those who teach English at the institute to regulate their own work, in all except its essential policy, and to adapt it, in so far as their various capacities allow, to their own powers and to the needs of the class. Under these conditions I must necessarily confine my account to a general view; and it is my purpose accordingly to discuss the underlying principles of this teaching, in so far as they seem likely to bear on the general problem of engineering education.

Students enter the institute on the basis of a high-school or college preparatory training. Therefore, as far as English is concerned, they come to us fresh from the study of the requirements adopted by the Commission of Colleges in New England. They have been reading selected works from the English classics, discussing their style and construction, writing appreciative essays about the characters which occur in them, or perhaps attempting "daily themes" on subjects of a supposedly more personal nature. In lieu of other models, however, we may fairly suppose that the style in this written work has been, consciously or unconsciously, molded after that of the classics studied. The works prescribed are, I believe admittedly, neither the most absorbing nor the most noble in the language. I doubt if they are such as the teacher himself would choose as the preferred companions of his idle moments; but rather they illustrate the general truth that we advise children and the young to undertake many tasks from which we ourselves should shrink. Of necessity, then, the college requirements in English are in many cases administered by the secondary school teacher as a medicine; and, in view of the pressure of preparatory work, in maximum doses. As a result of these conditions the engineering student enters the institute with strongly conceived notions about the study of English. He does not, as a rule, come of a "literary" family. Outside school requirements, his reading has been drawn chiefly from the *Scientific American* and perhaps the newspapers. In

school he has read "literature." Literature, therefore, is, to his mind, like his school reading, either dry, silly or incomprehensible. By the same token English composition, the making of more literature, is an art in which he sees no practical value. For teachers, newspaper men and clergymen the thing may be well enough; but it requires a special gift of phrase-making which he feels rather glad to acknowledge that he lacks.

The teacher who successfully combats this prejudice has accomplished a delicate task in persuasion. He must work toward this end along three lines: he must give the incoherent and undeveloped mind respect for its own productions; he must remove, as far as may be, the embarrassment of his own too critical presence; and, finally, he must attempt to show, as no rules of English composition derived from the study of models of literature ever can show, a rational aim in writing and an easily attainable attitude of mind which will lead to success. This is essentially the problem of teaching English composition at the Institute of Technology.

In attempting to solve this problem it is essential, above all things and at the very start, to give the student respect for his new attitude as author and, at least in prospect, for his new product. With this aim in view the student is at the outset usually requested to select his own subjects for written work. His attention is called to the fact that success can come only with topics which he cares about and knows. At the beginning of the first term, and again later, as need arises, he hands in a short list of subjects on which he prefers to write. These are tested, in the first instance, only as to the degree of knowledge and personal interest behind them. In a large school like the institute, which draws its students from all parts of the world, and in some cases from men of business and professional experience, the subjects present considerable range and some novelty. There is first the immature school boy, graduated from a neighboring high school, who has seldom left his native town. He has his favorite sports to tell of, hunting and fishing trips, perhaps an occasional criticism of high-school methods or of institute life. Beside him is the student who has traveled or lived abroad, or in distant parts of the United States, and is full of information as to unfamiliar methods of life and work. Finally comes the young man of professional experience, who is ready and glad, if he can find an instructor or a fellow student well enough informed to follow him, to expound deep matters, like the theory of injectors, or fire-proof electric wiring. Common to all these writers, and more promising than other subjects, are those which relate to business methods or manufacturing processes engaged in or observed—"The Duties of a Stage Hand," "The Working of a Small Steamer," "Surveying with a Party in Pennsylvania." Of the students I have met in the last five years, only about two per cent. failed to respond to this method and declared themselves utterly devoid of ideas; the rest were rather easily supplied with congenial subjects, and started on work which from the beginning they could take seriously. It at once presented itself to the mind as worthy of respect, because entirely within the limits of their powers of expression, and likely to be valuable to the reader after it was done.

The subjects thus presented are, when possible, neostyle-copied and handed about the class. At all events it is essential that the students should have access to the list. This makes for the class work the hour of promise—nature putting forth her power "about the opening of the flower." The most possible should be made of it. It remains only to shield the actual product

from too high a standard of criticism, and to provide each author, if possible, with sympathetic and intelligent readers. The class at large is no fitting audience. It demands, or seems to demand, too much, and frightens all but the more experienced or callous. Then again its mood is perhaps a little disingenuous. In attempting to hit its apparent taste one degenerates inevitably into smartness and after-dinner jesting. Individual critics chosen from among the students give better service. This plan may conveniently be followed if it is possible to neostyle-copy the lists of subjects. In that case each student explains briefly his proposed subjects, their general scope, method of treatment and point. Those who are interested in a particular subject signify their willingness to read the work, one of them is assigned as a critic, is later consulted by the author, and finally takes the instructor's place in giving a written criticism and correction of the finished theme.

This plan has some large theoretical advantages. It turns the youthful author over to critics of approximately his own age and experience. It relieves the teacher of some drudgery, and spares him the odium of fault-finding. Still, it should not be followed exclusively. One's fellow students are severe critics, but not usually sympathetic. Some will be misled by the titles, however fully explained, and find, perhaps, that they have more information than the author himself, or that they are not interested in the subject as he feels competent to treat it. Others will neglect to confer with the critics. This is perhaps the main danger. In the matter of instruction, both religious and secular, most of us think shame to adopt too serious an attitude, and even the boy who takes his studies most to heart will sometimes shrink from being known to do so. The whole question has been well handled by Mr. R. G. Valentine, in a paper "On Criticism of Themes by Students," in the *Technology Review*, Vol. 4, p. 459. Mr. Valentine there discusses the advantages of the plan as adopted in his own institute classes at the time. Whatever drawbacks may accompany them, these advantages undoubtedly exist. A considerable portion of every student's work should unquestionably be read by his fellows, and, in classes sufficiently small for constant supervision, perhaps the whole. Such criticism, if taken seriously, soon removes the impression that the teacher's fault-finding is professional; and it takes composition into the field where it belongs—the field of practical dealing between man and man.

This relation between man and man, this sympathy on which all successful writing is based, must in the end, of course, depend upon the human quality of the teacher himself. He must learn, in a thousand ways, not to take up his position where he shuts out the light. The distance between an undergraduate and a man of over thirty, especially when the man is burdened with the moral awfulness of the teaching profession, is in itself considerable. With a little lack of sympathy, a little giving way to cheap sarcasm, the gap may become so wide as effectually to stop all communication. The student has at the start no notion that his teacher is human; and if in the end the teacher himself forgets that he is so, it will be well to dismiss the class. The wise teacher, however, emphasizes points of contact, as he would in any other social relation. He resolves to be interested, instructed or amused. He looks upon the work handed him, not as an exercise which may contain interesting errors or violations of principles, but as an expression of character, however immature, and of attainments, however limited, such as he will not find precisely duplicated in any other person. He maintains

a liberal and a cordial spirit in his criticisms. For the moment he sacrifices the ends of teaching for those of inspiration. If there be any virtue and if there be any praise, he looks on these things; and for his reward the reading of themes, which his friends all think must be deadly boredom, rises to the importance of an end in itself. It introduces him to a circle of congenial spirits, each furnishing for his entertainment the best that the mental stores can supply.

In the mass of material which the teacher reads—not of course without hours of discouragement—one element of interest is never lacking. He sees, at least, the working out of his own theories, and he watches a growth, however slow, implanted and tended by his own hand. For the rest, though his sympathy is sometimes an ideal state, much of what he reads would be interesting in any connection. In his classes he is constantly meeting men who, aside from spelling and the principles of composition, are better informed than he. These men he encourages to write of what they know. In the past five years I remember many pieces of work that could hardly have interested me more if they had been literary ventures of my own. One man, not so far removed from boyhood as to need a razor, wrote for me on the social life of boys, and it happened that his conclusions, largely illustrated from his own experience, were not unlike my own. I suppose I shall never read in print so frank and faithful an account of that period which usually goes unrecorded. I had a long paper on Colorado forest reserves and timber protection, from the son of a large timber owner. A boy who had been brought up abroad wrote a series of essays on German school life and customs. The thing which perhaps gave me most enjoyment in watching its growth was a fairly complete account of the Fore River works at Quincy, Mass. The author was engaged on this the better part of a term, partly in interviewing men and collecting material. I watched his work at every step. In the end he read large extracts to the class and showed the photographs which he had taken. In the public reading—and not till then—it dawned upon him that his style was rough, and, whereas at the opening of the term he had no notion of turning a sentence, he became in the end, without a hitch in the natural development of his mind, his own critic of style. These men were interesting and interested because met on their own ground. I might, if it had seemed expedient, have assigned them subjects in treating which they would have bored both themselves and me to extinction; but on the other hand I should dislike excessively to handle many subjects that they, if they had the upper hand, might assign to me.

It is not so hard, then, for the teacher to be sympathetic; but sympathetic he must be at any cost. To secure that end he must in most cases criticize orally, not in writing. The complete explanation in writing of even a minor fault will often require enough red ink to discourage the elect; and then, ten to one, the fault is no fault at all, but the result of some text-book principle, too narrowly applied. Oral criticism is more expressive, and at the same time more modest. It assumes that all is fundamentally right, ascertains the meaning by questions, conceals that usually large part of the difficulty which arises from the critic's own stupidity, and suggests a way out of the remaining trouble. All this is no chastisement, but a very human and urbane process; it is merely what occurs every day when two people talk on a congenial subject and try to arrive at an understanding.

In the substance of this criticism as well there is a corresponding tempering of the

wind. The criticism of details is for a time kept in the background. The instructor pretends to believe, what no one really believes in these days, that the secondary schools have found time to teach grammar, spelling and punctuation. Faults in these may be weeded out later, but for the present it is remarkably sound doctrine that to pull out the tares destroys the wheat. There is an old moral story of a merchant who, wishing to test the quality of two boys who had applied for work, gave each the half of a garret to be set in order. One, the hero of the tale, sorted all the rubbish with infinite pains, brads and tacks, crooked and straight. The other, with a fine impatience, swept things into heaps and threw them from the window. The second lost the place, but I confess he has my sympathy; he seems to me to have had a juster notion of relative values than the other. At all events his temper of mind is like that of the average student. No young man of promise will work conscientiously at correcting minor errors in work which is confessedly rubbish. He must seek first the task in which he can take a vital interest, and then all these things shall be added unto him.

Greater closeness of relation with the instructor, as well as the habit of writing for classmates, will both tend to bring out clearly the central problem of writing—the adaptation of work to a particular audience. Even when themes are written directly for the instructor, the attempt is usually made, by preliminary conferences with the student, to impress upon him that he is not writing for a general court of appeal, but for an individual mind, with definite prejudices, ascertainable limits of knowledge, and individuality of point of view. In teaching the writing of essays in literary criticism or of sonnets, the instructor may well set up to be the embodiment of the laws of taste and good use. If he is accused of urging as authoritative opinions which ought rather to be regarded as personal, he can hide behind a multitude of admitted classical instances where it is very hard indeed to find him. In attempting, on the other hand, to teach an engineering student straightforward English prose for business purposes, it is necessary to assume a somewhat simpler attitude. One says, not "This is bad," but "I dislike it"; not "Your expression lacks force," but "You have not brought your argument home to me, and thus you have failed; for your whole object was to produce an effect on my mind." The student who sees his work treated from this point of view begins to find the problem of writing simplified. Composition for him takes on the look of a practical art, for it is after all only one department of the great business for which he is being educated, the business of dealing with men. Before it had seemed a mystery, like the concoction of some foreign dish. A compound of so much force, so much unity, and the rest, would make a dainty to tickle the teacher's palate. One had first to get together the somewhat mysterious ingredients—by no means an easy task; and in the end one was left wondering whether the teacher had not acquired a perverted taste. Instead of these unnatural relations, the pupil who has been taught to write directly for some classmate or for his teacher finds himself in a simplified position where he knows definitely what is expected of him, can himself measure the degree of his success or failure, and may keep within a safe distance of the manner and the matter to which his daily life and his conversations with his fellows have accustomed him.

As the term progresses and men get the notion that their writing is to serve some useful end, all sorts of other plans may be tried. They may even be assigned subjects, of a reasonable sort. At some time during

the term use is made of exercises bearing on the collection of facts and on observation, to the end that the student may in a degree learn how to observe, or at least to realize, why he has hitherto observed so little. To this end the class perhaps goes with the instructor to look at some relatively simple object, as the façade of a building. The natural sub-divisions are first discussed, and the order in which they may best be taken up; then the lines of observation essential to be followed in rendering each of these parts. After perhaps twenty minutes of this work, the men return with their notes to the class-room and write the report. Following this preliminary exercise under the eye of an instructor, more assignments are given out, of details of buildings, and features of natural or artificial interest about Boston, all being subjects on which the instructor has taken careful notes. The lesson of thorough and systematic observation thus begun is enforced by the assignment of subjects of a slightly different nature, from life, models or photographic enlargements. In all similar assignments for written work, the attempt is made to treat definite subjects, so that the results can be tested at any time, and criticized wholly, by an appeal to facts. Later in the year a more ambitious report is often attempted, involving not only natural but logical subdivisions, say on a neighborhood as a place of residence, or on a preparatory school. The subject is made general, but the student chooses that particular place or school with regard to which he has the most information. To help him in gaining what might be called self-consciousness, an articulate recognition of the ideas which are lying unrealized in his mind, he is given a list, as complete as it can be made, of the observations which would be pertinent, for instance the things necessary to be looked out for in selecting a place of residence. It is usual in this work to leave the determination of the scope and mode of treatment to the student; and the result in most cases is a long, detailed, relatively mature, and often admirably arranged report, of from ten to fifteen pages of theme paper—the ordinary letter sheet.

These reports, thus constructed, are essentially like the engineering report of later years, and in this connection it is usual, when time permits, to study at least one engineering report, with an analysis of its headings, as showing the divisions of the subject, and the sort of observations which the engineer has thought it advisable to make under each head.

Thus there has been in the English instruction at the institute a conscious and, I believe, a conscientious effort to meet the conditions imposed by the needs of a technical school. The teaching differs fundamentally, both in spirit and in methods, from the instruction in English composition given in academic colleges. I myself was put through all the training offered in this line by one of the foremost eastern colleges; yet there were certain ideas which seem to me fundamental in the training of engineers that, so far as I can remember, were never hinted to me. Part of the explanation for this is doubtless drawn from my undergraduate stupidity, but not all; for I did absorb several strong impressions more or less opposed to these. It never occurred to me that fact is the background of all writing; or that a man has no business to write about matters of which he is ignorant; or that the substance is primary to the form; or that writing, like speech, is for the sole purpose of producing an effect upon some other mind and that all its laws must be derived from the consciousness of this fundamental principle.

The great present needs of such teaching

of English composition as I have described are two. The first is closer contact with professional departments. Such contact has already been secured to some extent in the higher years, where professional reports are reviewed by members of the English department. This, however, is likely to resolve itself into a mere correction of faults in the technique of expression. What is needed rather is discussion and reports in which from the outset the teacher of engineering and the teacher of English shall cooperate; which shall be both conceived and carried out with the purpose not only of securing accuracy in details of fact, but also of studying the theories of thought and of expression which underlie such work. For instance, in connection with the reports spoken of above, it has for some time been a dream, unrealized as yet on account of tabular view adjustments and other practical difficulties, that first-year students might be taken in small sections, in the company of an instructor from an engineering department and another from the department of English, to study and report on some simple assignment along the lines of their chosen profession. The experiment, I believe, would be worth all the trouble of arrangement, and would do much in stimulating their powers of observation and in teaching them that the mastery of an English style is no ornamental acquisition, but the means of expressing yourself, your attainments and your facts, so as to become a moving force in the world.

The second need of this teaching is that of teachers. In other subjects, teachers—the good ones—are said to be born, not made. The ideal teacher of composition could hardly be born, for the limitations of human nature preclude him. To criticize all thought—the substance of it, from which alone the form depends—to sympathize with every point of view, to win the confidence of every type of mind—these tasks require some genuine magnanimity of soul. No man can fully meet so large a requirement, yet here and there are found persons not ill adapted on one side or another for the task. Nothing can come amiss—scraps of general information, breadth of interest, the power of drawing out other people's ideas, above all warmth of heart. Meanwhile with whatever equipment, lucky if with a trace of some necessary quality, one does one's best. It is at least something to have conceived the sort of man one ought to be.

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THE CONDITIONS AFFECTING CHEMISTRY IN NEW YORK[1]

IN assuming the chair, I am confident that the coming year will be one of great progress in our section's history, not through any merit of its officers, but through the ever-increasing spirit of cooperation among the members, and the rapid strides which research and industry are making in this country. You will hear reports, this evening, of two important general meetings that interested our membership, that of our own society at Detroit and that of the International Congress of Applied Chemistry at London. In both, members of this section bore a worthy share, and it is a gratifying tribute to American progress in science and industry, that the International Congress chose America for its next meeting-place. It is not only the foreigner who lands at Ellis Island that deems America synonymous with New York, and the members of this section must be prepared to do their full duty, during the next three years, in order that our foreign brethren may carry back

[1] Address of the chairman of the New York Section of the American Chemical Society, delivered October 8, 1909.

from their visit a crystalline rather than a colloidal vision of chemistry in America.

And so, gentlemen, I have preferred to devote the minutes which custom permits your chairman to employ in airing his personal views, to a survey of the conditions affecting chemistry in New York, rather than to the presentation of some debatable scientific ideas, as I had originally intended. The choice of the more subjective topic is rendered more appropriate by the fact that this meeting is to be followed by a session of the Chemists' Club, called for the purpose of settling a question vitally affecting the interests of New York chemists.

Eighteen years ago, when the men who had carried the American Chemical Society through so many vicissitudes organized this section, in order that the general society might become a truly national one, I had the honor, rather than the duty, of being the first local secretary. The meetings were so poorly attended, the original papers so scarce, and the general business so unimportant, that no heavy work developed upon its officers. We met in the chapel of the old university building, where Professor Hall and I had our primitive laboratories, out of which we carved, with some difficulty, shelf-room for the fragmentary society library. When we felt in need of a little variety, we sat in Professor Chandler's lecture-room in 49th Street and listened to the passing trains; or in East 23d Street, peered at the chairman ensconsed behind batteries of Professor Doremus's bell-jars and air-pumps. An attendance of forty members, I believe, was a record-breaking event.

I need hardly expatiate upon the wonderful changes that have been wrought since 1891. Our three colleges have moved far up-town, and the splendid Havemeyer Laboratories of Columbia and New York University, and the beautiful new chemistry building on St. Nicholas Terrace, make us glad to miss the dingy and crowded places where chemistry was taught an academic generation ago. Our own section and kindred societies have been meeting in this hall of the Chemists' Club for the past ten seasons, and no one can estimate what share a fixed and commodious meeting-place has borne in the marvelous increase in membership and attendance. The other important factor is, of course, the growth of chemical industry in this vicinity.

While we can, therefore, congratulate ourselves upon the great strides that have been made, during the past two decades, it behooves us to inquire whether there are not still some drawbacks to our progress, not by way of carping criticism, but for the purpose of seeking such effective remedies that future progress may be made absolutely certain.

For obvious reasons, we need not ask whether the internal conditions in the chemical factories are satisfactory; since there the managers must know that their success depends upon the scientific abilities of their chemists. It is doubtful whether the same can be said of the establishments which employ a chemist or two to apply specific tests; and it is certain that there are still many factories which conduct, by rule of thumb, operations that should be continually controlled by scientific tests, if shameful waste is to be avoided.

The American people are but slowly learning the importance of the educated banker and the expert accountant alongside the brilliant financier and the bold speculator; similarly, while they acclaim the clever inventor and the skilful engineer, they have yet to recognize the worth of that expert accountant of material economy, the industrial chemist. Quite aside, therefore, from any wish for greater profits to our associates who are gaining their daily bread as commercial or analytical chemists, pa-

triotic motives lead us to the earnest hope that closer watch upon the economy of production may bring about that conservation of natural resources of which the politicians prate, but for which the chemist works. How, then, can the status of the independent commercial chemist be raised in our city? By giving him a central rally-point; a home that proves to the layman that his is a skilled profession, not a mere job-hunting trade; a place where the manufacturer or merchant can find the man he wants without a rambling search through the city directory. Doubtless, some of our colleagues are so well known, that all the business comes to them which they can handle. But the many additional independent chemists, whom our commercial situation demands, can only establish themselves if they can secure proper laboratory facilities, without hiring attics in tumbledown rookeries.

Every year scores of New Yorkers graduate in chemistry from our local institutions and return from years of protracted study in other American and European institutions. They are enthusiastic for research; in completing their theses they have laid aside definite ideas for subsequent experimentation; but they have no laboratory. While waiting to hear from the teachers' agency where they have registered, while carrying on desultory correspondence with manufacturers who *may* give them a chance, they do not venture upon expenditure of time and money to fit out a private laboratory, which they may be called upon to quit any minute upon the appearance of that desired appointment. Often necessity or tedium will cause them to accept temporary work of an entirely different character and indefinitely postpone the execution of the experiments which they had mapped out. Who will estimate the loss of scientific momentum, the economic and intellectual waste, which this lack of laboratory facilities for the graduate inflicts upon New York, as compared with Berlin, Vienna, Paris and London? Either our universities and colleges, or private enterprise, should provide temporary desk-room for the independent research chemist.

So much for the purely practical side of our question? How about the opportunities for presenting the results of investigation? We all appreciate the excellence of the three chemical journals published by our own society, as well as that of the Society of Chemical Industry, and we may say that these, together with the independently conducted periodicals, enable everybody to obtain a hearing; but it does seem to me that the cost of subscribing to all of these journals is excessive, and that much unnecessary expense is incurred through duplication of administrative efforts, as well as through duplication of abstracts, etc. This, of course, is a problem with which we, as a local section, are not directly called upon to deal; nevertheless, it is proper to call the attention of those who are interested in the management of chemical societies in America to the fact that membership alone in the various chemical organizations of New York costs upward of $50 per year, and that it would be but fair to so arrange matters that the total cost would be reduced by a sort of clubbing arrangement, proportionately to the number of societies to which a member belongs. It seems to me, however, that in one particular point we are at a distinct disadvantage as compared with the foreign chemists: the frequency of regular meetings at which papers can be presented for the purpose of securing priority of publication. Would it not be possible for our various local sections, including the Chemical Section of the New York Academy of Sciences, to arrange the dates of their meetings conjointly in such a way that a meeting would occur once a week during

nine months, and once a month during the summer, thus securing for the New York chemist the same opportunities for the early presentation of a scientific discovery that are possessed by his brethren in European centers? There is, of course, another remedy which appeals to me, though I do not express it with any degree of urgency; namely, the consolidation of all local sections into a single organization which would affiliate its members automatically with all the national bodies now in existence, and would turn over the scientific material of its meetings to those journals for which it seemed most suited. As a matter of fact, glancing over the annual lists of our various local organizations, I find a remarkable interchangeability of officers, and can hardly imagine that the interests of their memberships can be very far apart if the chairman of the New York Section of the American Chemical Society in one year is the next year expected to guide the fortunes of the New York Section of the Electrochemical Society, or of the Society of Chemical Industry. If this were done and we could then exert our influence upon the various general societies to avoid duplication of work, by issuing their chemical abstracts jointly, the strain on the purses as well as the shelves of American chemists would be greatly relieved.

There is still another point, however, in which the American chemist is at a great disadvantage as compared with the European: the ease of securing material for his research and of comparing his results with those of others. In Europe, especially in Germany, research is never seriously delayed by lack of a needed preparation, whereas none of our supply houses carry a full stock of chemicals. To obtain a single gram of some particular substance, needed for a few preliminary tests, frequently causes weeks of delay, as well as the disproportionate custom house and brokerage expenses involved in the importation of small quantities. Besides, owing to the better centralization of scientific laboratories in Europe, and the existence in each case of a fairly complete set of specimens, accumulated in the researches of large numbers of academic investigators, it is comparatively easy to obtain by correspondence research material or typical specimens for comparison. In this country, on the other hand, laboratories are scattered throughout the numerous colleges and universities, and there are no established rules by which specimens must be deposited with the laboratory. In smaller laboratories, especially, the chances of preservation after the departure of the investigator are not very good. It would be, consequently, very much more difficult to obtain such specimens here. I would suggest, therefore, that a chemical museum be established in New York, to perform for the American chemists the functions that the Smithsonian Institution so admirably carries on for the benefit of American naturalists. This museum would not attempt to be a popular show-place, but would embody, in the first place, as complete a collection as possible of chemically pure materials of the rarer kinds, so as to supplement, but not in any manner compete with, the stock of commercial supply-houses. Any scientific investigator would be entitled to borrow or purchase material required for immediate experimentation, and all used articles would be replaced as quickly as possible.

In the second place, it would be the depository for specimens of new substances obtained in American research. Every chemist would be invited to send to the museum a small quantity of each substance newly prepared by him, not, indeed, as an evidence of the good faith of his investigation, but, rather, to enable future workers to obtain such material, either for

comparison, or for further experimentation with the least possible delay. Many substances that are now carried away from universities by students who subsequently abandon chemical research, or which belong to the families of deceased chemists who do not know what to do with them, would thereby be rescued from oblivion, and might ultimately become of the greatest value for a special purpose.

Thirdly, this museum would invite chemical manufacturers to send standard samples of their products, and thereby facilitate the commercial relations between consumer and manufacturer.

To such a museum there could be attached a competent staff of workers for the preparation of materials not otherwise available. In the analysis of samples submitted as official standards, we should have the beginning of that Chemische Reichsanstalt which is now the chief object to which German chemists are directing their attention.

The past twenty years have seen the construction of innumerable teaching laboratories in our vicinity. They have seen an undreamt of development and growth of chemical industry, and, above all, they have seen the coming together of the scattered chemists into a large and powerful society. Now is the time when we should make every effort to direct these forces that we have marshaled toward the attainment of definite objects, and coordinate all our enterprises in those directions that will make for the improvement of the intellectual as well as the material conditions of our beloved city.

MORRIS LOEB

RARE BIRDS IN THE NEW YORK ZOOLOGICAL PARK

It may be of interest to record the fact that in the collection of living birds in the New York Zoological Park, there are at present an unusual number of rare species of especial interest to students of evolution. Many are representatives of isolated families or even orders and the majority are neotropical in habitat.

The family Ciconiidae or true storks are represented in the new world by only three species, all of which are now living in the Zoological Park.

The Maguari stork, *Euxenura maguari* (Gmel.), is represented by two specimens, noteworthy as paralleling closely the European white stork, *Ciconia ciconia* in color, but excelling it in size.

The other two American storks are the jabiru, *Mycteria americana* Linn., and wood ibis, *Tantalus loculator* Linn. It is better even for technical purposes to call these by their vulgar than their scientific names, as our over-zealous systematists have recently deftly exchanged their Latin cognomens. Until these new radical changes are approved by some international board, it seems better to use the world-wide *Tantalus* (wood ibis) and *Mycteria* (jabiru).

The former is a common bird always on exhibition, but the jabiru is much rarer, and the splendid individual now in the park is only the second one which we have been able to obtain.

The genus *Chauna* of the order Palamedeiformes is complete, both species of screamer, the black-necked, *C. chavaria* (Linn.), and the crested, *C. cristata* (Swains.), being in the collection.

But the most significant series is of the so-called suborders of Gruiformes or crane-like birds. Four out of the six suborders are represented; the Arami by the limpkin, *Aramus giganteus* (Bonap.); Eurypygæ by the sun-bittern, *Eurypyga helias* (Pall.); Psophiæ by the common, *Psophia crepitans* Linn., and the white-backed trumpeters, *P. leucoptera* Spix.

Finally, the only two species of Dicholophi are both in the collection, viz.: the crested, *Cariama cristata* Linn., and Burmeister's seriema, *Chunga burmeisteri* (Hartl).

Among other noteworthy species of birds may be mentioned both sexes of the harpy eagle, *Thrasaëtus harpyia* (Linn.); two Cali-

fornia condors, *Gymnogyps californianus* (Shaw), one just shedding the last of its natal down while the other, at the age of three years, has just acquired the fully adult head colors and gular swelling; black cockatoo, *Calyptorhynchus banksi* (Lath); satin bower bird, *Ptilonorhynchus violaceus* (Vieill); and sacred ibis, *Ibis æthiopica* (Lath). A pair of ocellated turkeys, *Agriocharis ocellata* (Curv.), just acquiring adult plumage and coloring is perhaps the rarest species in the entire collection.

The series of American warblers is as complete as ever, and an excellent beginning has been made on the birds of our western deserts, as the following list will show: phainopepla, ptilogonys, white-rumped shrike, western blue grosbeak, pyrrhuloxia, house finch, western lark sparrow, lark bunting, gambel sparrow, western vesper sparrow, Abert desert towhee, dickcissel, dwarf and red-eyed cowbirds, Sonoran redwing, Texas meadowlark, great-tailed grackle, Rio Grande green jay, besides many larger forms such as scaled quail, roadrunner, etc.

C. WILLIAM BEEBE,
Curator of Ornithology

INTERNATIONAL CONFERENCE ON THE 1:1,000,000 MAP OF THE WORLD

AT the Fifth International Geographical Congress at Bern, in 1891, Professor Albrecht Penck first proposed that the enlightened nations who were engaged in making maps of their own territories and of other countries should unite upon a common plan for the execution of a general map of the world. He suggested that the scale of the map should be 1:1,000,000, or about 16 miles to the inch, and that the separate sheets of the map should be so bounded by meridians and parallels that any one sheet would match any other except for distortion of projection, no matter by what country either sheet might be made. This proposal led to resolutions and discussions at successive geographic congresses and to several tentative maps made by Germany, France, England and the United States as essays toward the general plan.

At the ninth congress at Geneva in July, 1908, a resolution was presented by Mr. Henry Gannett, of the U. S. Geólogical Survey, with a view to the formation of an international committee to which should be entrusted the details of arrangement which should lead to more definite cooperation in the preparation of the world map. Following the adoption of that resolution and the recommendations of the committee at Geneva, the British government has recently sent out invitations to Austria-Hungary, France, Germany, Italy, Japan, Russia, Spain and the United States, for a meeting of the committee in London on November 16, to proceed with the standardization of the international map on the scale of 1:1,000,000. The British delegates will consist of representatives of Great Britain, Canada, Australia and India. At this conference the various details essential to an agreement on the preparation of a uniform map will be discussed and it is hoped adjusted.

The United States Geological Survey has for some time past been engaged in compiling maps of portions of the United States on the 1:1,000,000 scale and in accordance with a plan which is believed to embody the principal features on which agreement with other nations is expected.

In view of the interest which it thus has in the results of this conference, Messrs. Bailey Willis and S. J. Kubel, of the U. S. Geological Survey, have been instructed to proceed to London as representatives of the United States.

MR. KENNEDY'S BEQUESTS

BY the will of John Stewart Kennedy, the banker of New York City, who died on October 31, in his eightieth year, bequests are made for public purposes amounting to nearly $30,000,000. Seven of the bequests are of $2,225,000 each, and are, respectively, for Columbia University, the New York Public Library, the Metropolitan Museum of Art, the Presbyterian Hospital in New York City, and to three of the boards of the Presbyterian Church. Bequests of $1,500,000 are made to Robert College, Constantinople, and to the United Charities of New York. Bequests of $750,000

are made to New York University and the Charity Organization Society of New York for its School of Philanthropy. Bequests of $100,000 are made to the University of Glasgow, Yale University, Amherst College, Williams College, Dartmouth College, Bowdoin College, Hamilton College, the Protestant College at Beirut, the Tuskegee Institute and Hampden Institute. Bequests of $50,000 are made to Lafayette College, Oberlin College, Wellesley College, Barnard College (Columbia University), Teachers College (Columbia University), Elmira College, Northfield Seminary, Berea College, Mt. Hermon Boys' School and Anatolia College, Turkey. Bequests of $25,000 are made to Lake Forest University and Center College. A bequest of $20,000 is made to Cooper Union. There are also a number of other bequests to hospitals and charities.

Mr. Kennedy was a liberal benefactor in his life time and probably stands third among men in the history of the world who have given most largely for public purposes.

SCIENTIFIC NOTES AND NEWS

Professor J. H. Van Amringe, head of the department of mathematics in Columbia University, and dean of the college, will retire from active service at the end of the present academic year, when he will have completed fifty years of service for the institution and reached his seventy-fifth birthday.

The Bakerian lecture before the Royal Society will be given on November 18 by Sir J. Larmor, on "The Statistical and Thermodynamical Relations of Radiant Energy."

Professor Joseph P. Iddings is at present traveling along the east coast of Asia. In September he visited the southern part of Manchuria, making a study of certain Cambrian rocks there. He expects to visit Manila about thanksgiving time, and while there will take occasion to see something of the volcanoes on the island of Luzon.

During the past month the newspapers have printed more or less sensational and alarming reports with reference to a geological exploration party which made a trip during the summer to the east shore of Hudson Bay under the leadership of Dr. C. K. Leith, of the University of Wisconsin. Under these circumstances it will be gratifying to acquaintances of the members of the party to learn that they have reached the railway north of Cobalt, Ontario, and will be in the United States before this notice is printed.

The Telford gold medals of the British Institution of Civil Engineers have been awarded to Professor B. Hopkinson and G. R. G. Conway; the Watt gold medals to D. A. Matheson and W. C. Popplewell and the George Stephenson gold medals to E. H. Tabor and A. J. Knowles.

A gold medal has been presented to Dr. Oswaldo Cruz in recognition of his services in extirpating yellow fever in Rio de Janeiro.

Dr. Theodor Weber, emeritus professor of medicine at Halle, has celebrated his eightieth birthday.

Dr. Simon Schwendener, professor of botany at Berlin and director of the University Gardens, will retire from active service at the end of the present semester.

Dr. August Brauer, director of the zoological museum of the University of Berlin, has been given the title of honorary professor.

At Cambridge University Mr. H. H. Thomas has been appointed curator of the Botanical Museum, and Mr. C. L. Boulenger, assistant to the superintendent of the Museum of Zoology.

Professor Harry Snyder has resigned the chair of agricultural chemistry at the University of Minnesota, which he has held since 1892.

Sir William Turner has been elected president, and Professor G. Crystal general secretary, of the Royal Society of Edinburgh.

Professor L. A. Herdt, head of the department of electrical engineering at McGill University, has been appointed honorary secretary for Canada of the American Institute of Electrical Engineers.

Professor Josephine E. Tilden, of the University of Minnesota, is at present in New Zealand, with leave of absence for a year for botanical research. Her courses at the Uni-

versity are being taken by Mrs. Frederic E. Clements.

DR. E. P. FELT, state entomologist of New York, has received a two-months' leave of absence for study in European museums.

PROFESSOR GUSTAV RETZIUS gave on November 5 the annual Huxley lecture before the Royal Anthropological Institute. His subject was "The North European Race."

ON Mondays and Thursdays, from five to six P.M., in the Harvard Medical School, Professor W. T. Porter will give a physiological demonstration with an informal lecture.

COMMEMORATION exercises were held at the Massachusetts General Hospital, on October 16, in honor of the anniversary of the first use of ether by Dr. William T. C. Morton. Dr. Charles W. Eliot delivered the address.

DR. WILLIAM TERRY HARRIS, for many years U. S. Commissioner of Education and eminent for his contributions to education and philosophy, died on November 5, at the age of seventy-four years.

THE death is announced of Dr. C. Gottsche, director of the Hamburg Geological Institute.

A TABLET in memory of Ross Gilmore Marvin, the Cornell graduate and instructor who was drowned while on the Peary expedition to the north pole, will be placed in Sage Chapel by the students of Cornell University.

IN view of the rapid rate at which accommodations are being taken up for the transatlantic passage for the spring of 1910, it seems advisable to call the attention of those intending to participate in any of the scientific congresses of next summer to engage their passage as soon as possible. In the middle of October every place on the North German Lloyd boats running to the Mediterranean next June was already engaged, except some at a high price. Some of the other lines are nearly as fully engaged.

SIR RAY LANKESTER writes to *Nature* that he has heard from the representatives of the late Professor Anton Dohrn to the effect that the Zoological Station at Naples remains the property of the heirs of its founder. Neither the German government nor any German society has acquired any rights in its future disposition. Dr. Reinhardt Dohrn, who has for two years been the acting director of the station, is now director, and has inherited from his father (by agreement with his brothers) the actual property and the leases granted by the Naples municipality as to the site.

THE British Medical Association will hold its annual meeting next year in London under the presidency of Dr. H. T. Butlin, president of the Royal College of Surgeons. The association has held its annual meeting in London on three occasions. The first was in 1862, when Dr. George Burrows was president; the second in 1873, when Sir William Ferguson was president; the third in 1895, when Sir J. Russell Reynolds was president.

THE Central Association of Science and Mathematics Teachers will hold its annual session at the University of Chicago on November 26 and 27.

A BRANCH of the hygienic laboratory of the department of health of New York state has been established at Ithaca, under the supervision of Professor H. N. Ogden.

ACCORDING to a dispatch from Vienna the Austrian government will put upon the market a portion of the 154 grains of radium chloride, the product of the St. Joachimthal (Bohemia) plant, for 18 months. The Vienna hospitals and scientific institutions are to be supplied first, free of cost, the remainder to be offered for sale at $75,000 a gram.

THE *British Medical Journal* says: The Pasteur Institute, Paris, will shortly come into possession of a capital sum estimated at 30,000,000 francs, the product of the estate of the late M. Osiris, which is now being realized. The circumstances under which M. Osiris determined to dispose of his great fortune in this way are, if rumor speaks true, most striking and dramatic. In 1903 M. Osiris founded a triennial prize of £4,000, to be given to "the person who had rendered the greatest service to the human race during the three preceding years." The prize was awarded to Dr. Roux, director of the Pasteur Institute, for the discovery of the anti-diphtheria serum. Instead of devoting the

money to his own private purposes Dr. Roux made over the sum to the Pasteur Institute. This self-denying action so impressed the millionaire that he left the bulk of his fortune to the institute as a token of admiration for the scientific attainments and self-abnegation of Dr. Roux. M. Osiris could not have made a better disposition of his wealth; the Pasteur Institute is greatly in need of funds, and this endowment will firmly establish it as a monument worthy of the great master. The memory of M. Osiris as a benefactor of the human race is effectively perpetuated by this princely munificence, and the scope and influence of the valuable work of the Pasteur Institute will be vastly increased.

We learn from the London *Times* that the new Astronomical and Meteorological Observatory at Hampstead, the undertaking of the Hampstead Scientific Society, is now nearing completion. On the reservoir, near the Whitestone Pond, Hampstead-heath, are to be seen the small observatory house and the railed enclosure in which will be placed those meteorological instruments that require to be in the open. It is expected that the next fortnight will see the telescope placed in position, and the rain gauge, thermometer screen, sunshine recorder and barometer ready to give account of the climate of London's highest hill. The revolving dome of the telescope house has been designed and made by Mr. John Reid, of Manchester, and the meteorological instruments are being supplied by Mr. James J. Hicks. The telescope, which has been presented to the society by Dr. F. Womack, professor of physics at Bedford College and St. Bartholomew's Hospital, is an equatorially mounted reflector; the mirror is by Sir Howard Grubb, of Dublin, and the mounting by Wray. To the appeal for funds to defray the cost a generous response has been made. The sum involved will be about £250, and towards this £239 has been received.

The recently founded Italian national league against malaria held its first meeting on October 6 at Milan under the presidency of Professor Baccelli. The *British Medical Journal* states that Senator Golgi, as chairman of the local organizing committee, delivered the opening address, in which, he referred to the vast improvement due to the law of compulsory supply of quinine to laborers; in a few years the mortality from the disease had diminished by three fourths. As regards agricultural and water-supply betterments, he recognized that so far the results had not been very encouraging; he hoped, however, that the laws made on the subject would not continue to remain a dead letter. In regard to human beings, the improvement was beyond all question. Where the measures were carried out rigorously, it had been shown by Negri that the disease disappeared so completely that not a single case was to be found in the following year. Golgi did not, however, think that the general adoption of prophylaxis by the systematic administration of quinine to healthy people was justified. On the other hand, mechanical prophylaxis by the use of mosquito netting on the doors and windows of dwellings gave satisfactory results. The efforts of the league should, he urged, be directed to the application and perfecting of the methods already known, and to the study of new means of combating the disease. Professor Baccelli, who next spoke, suggested that a national, or even an international, congress against malaria should be held in Rome in 1911. Then the league would have the opportunity of demonstrating publicly the work it had done up to that time. He announced that the government would hand over for the purposes of the league the profits made on the sale of quinine by the state. The central committee was then constituted as follows: Professor Baccelli, president; Professor Golgi, Professor Lustig, Professor Gosio, Dr. Picchi, Professor Gobbi, Professor Di Mattei, Professor Canalis, Senator Ponti and Signori Badaloni, Villaresi and Cabrini.

UNIVERSITY AND EDUCATIONAL NEWS

The appropriation for the College of the City of New York for the year 1910 amounts to $613,000. Of this sum $440,000 is for instruction.

BY the will of the late Mrs. Gardiner Green Hubbard the sum of $50,000 is bequeathed to the Clark School for the deaf at Northampton, Mass.

THE tenth industrial fellowship to be established under the management of Professor Robert Kennedy Duncan has been presented to the University of Kansas. It is for the investigation of the chemical treatment of wood, and is of the value of $1,500 annually for two years. The donor is a furniture firm.

FIRE started last week in the basement of Culver Hall, Dartmouth College, where the laboratories of the chemistry department are located. Considerable damage was done to the scientific apparatus, and the building is temporarily closed for repairs.

THE entire board of regents of the University of West Virginia will spend two weeks in January studying the University of Wisconsin in its organization, methods of instruction, buildings and equipment.

DR. ERNST J. BERG, of the General Electrical Company, has been appointed head of the department of electrical engineering at the University of Illinois. In this position he succeeds Professor Morgan Brooks, who is at present abroad, and who will return to take up his duties as professor in the department.

THE department of physics and electrical engineering at the Iowa State College has been divided into two distinct departments. Professor L. B. Spinney will continue the head of the department of physics, and Professor F. A. Fish has been appointed the head of the electrical engineering department. A new building has been completed for the work of the electrical engineering department.

THE departments of geology and geography at Cornell University have been reorganized and divided into five coordinate departments. These are geology, in charge of Professor Henry S. Williams, who is also director of the museum; physical geography, in charge of Professor Ralph S. Tarr; stratigraphic geology, in charge of Professor Gilbert D. Harris; economic geology, in charge of Professor Heinrich Ries, and mineralogy and petrography, in charge of Professor A. C. Gill. Professor Gill will also be chairman of the five departments.

MR. RALPH HOAGLAND has been elected professor of soils at the University of Minnesota.

DR. W. W. DIMOCK has been appointed associate professor of pathology in the veterinary department of the Iowa State University and pathologist to the experiment station. For the last three years Dr. Dimock has been in the employment of the Cuban government.

RECENT appointments at the New Hampshire College of Agriculture and the Mechanic Arts are as follows: T. S. Arkell (B.S., Ontario '07), assistant professor of animal husbandry; Frank C. Moore (A.B., Dartmouth '02), assistant professor of mathematics; T. G. Bunting (B.S., Ontario '07), instructor in horticulture; L. A. Pratt (B.S., New Hampshire '09), instructor in chemistry; W. C. O'Kane (A.B. and A.M., Ohio State), instructor in entomology.

THE following new appointments have been made in the chemical department of the University of Illinois for the current year: *Instructors:* R. H. Jesse, Ph.D., Harvard University, L. L. Burgess, Ph.D., Harvard University, Ellen S. McCarthey, Ph.D., Cornell University; *Research Assistant:* L. P. Kyriakides, Sc.D., University of Michigan; *Assistants:* R. H. Stevens, M.S., University of Chicago, L. F. Nickell, B.S., University of Illinois; *Graduate Assistants:* W. T. Murdock, R. W. Savidge, L. M. Burghardt, F. W. Kressman, C. E. Millar, J. W. Marden, C. J. Baker, R. S. Potter; *Fellows:* A. W. Homberger, C. E. Burke.

DR. ALFRED GRUND, of Berlin, has been appointed professor of geography, in the German university of Prague, to succeed Professor Olenz, who has retired.

DISCUSSION AND CORRESPONDENCE

AUTONOMY FOR THE UNIVERSITY?

America has not yet contributed her share to scholarly creation, and the fault lies in part at the doors of our universities. They do not strive enough in the impressionable years of early manhood to stimulate intellectual appetite and ambi-

tion; nor do they foster productive scholarship enough among those members of their staffs who are capable thereof.

THESE words, indicative as they are of a courageous desire to attempt the mastery of one of the most complex problems of higher education of the day, I heard uttered by President Lowell in his inaugural address in the Harvard Yard.

In some respects the aims of the college and of the university are different or even antagonistic. The college strives to impart knowledge, the university to extend its boundaries. The college is the husbandman, the university the explorer in intellectual fields. Without the explorer's spirit for research knowledge crystallizes into mere erudition, but the college itself is of more fundamental importance, for without its fostering influence culture itself must wither into barbarism.

Indeed, our times demand a broad foundation in general culture for the erection of the pinnacle of special training, and thus it is that our best schools of law and medicine are now demanding that those who enter shall be college graduates. It is the aim of modern education to teach the student to know a little of many things and much of some one thing, and even more important is it for the graduate to realize that he knows but little of all things, and that far beyond the range of his intellectual vision stretches the unknown inviting his exploration. There are, therefore, two sharply contrasted aims in higher education—the foundation in general culture which it is the duty of the college to impart, and surmounting it that special training which only the professional school can give.

In other words, the wealth of modern knowledge has brought about a separation in aims between the college and the university, and necessitates a segregation of their faculties, while at the same time making the university more than ever dependent upon the college for that basic store of learning from whose safe boundaries expeditions into the unknown may be launched. Yet in America to-day our so-called universities are but overgrown colleges, and their graduate departments are still mainly normal schools for the training of college teachers. Moreover, the historic experiments in education evidenced by Johns Hopkins and Clark Universities have shown that in our country the university can not stand alone without the coordinated support of its preparatory school—the college.

Research suffers grievously in our overgrown colleges through our failure to realize that there are two sorts of intellectual leaders in the world—those who are erudite expounders of learning, and those who advance its boundaries.

In manufacturing and in commercial walks of life it has long been known that the highest results are achieved only through a judicious division of the tasks with respect to the several abilities of those who are to perform them, and in our system of education the greatest efficiency will be attained only when the productive student is not overburdened with elementary teaching, and the erudite is expected to teach rather than to discover. Yet at the present day little or no such segregation is attempted, and indeed the tendency is increasingly to overwhelm the young investigator with pedagogical duties.

Most pernicious to the development of the spirit of research is the extraordinary growth of summer schools in connection with our colleges; and the consequent demand that young instructors forego research and teach throughout the year. In many of our colleges the young men are now forced to teach in summer schools, but even where this is not actually obligatory their small salaries practically necessitate it.

There have been summer schools such as that of Penikese years ago, whose ideal was research and whose aim was discovery, but the hurried and superficial teaching of the present-day college summer school places it not among these. But while it is the proper aim of the college to develop and above all to improve the summer school, its presence in its present form is most hurtful to the progress of university research.

It is the aim of the college to teach, it is the hope of the university to discover; and the demand of the university spirit of the day is

that it be given autonomy to solve its problems in cooperation with, but not under the control of, the college.

The cause of knowledge would be advanced by the establishment of schools of research in connection with our great colleges, and by permitting them, as in Germany, to elect their own faculties from among those college teachers whose genius is for discovery rather than for exposition of knowledge.

ALFRED G. MAYER

NATIONAL EDUCATIONAL RESPONSIBILITIES

"OUT of a full heart the mouth speaketh." The hour will come when valiant Dr. E. C. Moore will clearly recognize as blessings in disguise the great obstacles he has overcome in one of the most dastardly and malicious attacks the school system of an American city has yet encountered. Full endorsement of his general views, as expressed in a recent issue of SCIENCE,[1] is given freely and from somewhat varied experience of the most convincing character. The questions catalogued in the article cited are such as insistently demand settlement, and it would be a large step forward to realize, in some way, authoritative answers to these queries and to many others of equivalent importance in education, which now can not reach a final bar of judgment, except by tortuous indirection. Perhaps the dignifying of the U. S. Commissioner of Education with title and prestige of a member of the president's cabinet might go far to accomplish this end. And there is, no doubt, greater need and greater reason for such action than for certain similar schemes promulgated for advancing less vital and more selfish interests.

While thus completely in accord with Professor Moore in his advocacy of increasing the powers and responsibilities of the national commissioner, it is difficult to understand how this measure, of itself, can rectify the evils outlined in the aforesaid article, and those especially which have been heretofore the chief obstacles in the pathway of the superintendent of schools of Los Angeles and his coworkers. The poorly devised (*sic*) system in California, which almost invites conflict of city council and board of education in financial estimates, might be deprecated by a national secretary, but state legislatures are bomb-proof and wholly invulnerable, save by one kind of ammunition, viz., the ballots of the voters. Mr. Moore's own recent victory in Los Angeles illustrates this fact conclusively, and it is difficult to understand how any added power within practicable bounds could have rendered even an official of the president's council more effective in meeting this unseemly attack than was the aroused public opinion at the most critical juncture.

In so far as the strengthening and enlarging of the power and scope of the national department of education may be effective in the unbiased study of many complicated problems and in the wider dissemination of facts and comparisons among the people, no obstacle should be thrown in the way of this proposition. But the fact remains that the machinery by means of which reforms must be introduced will not be changed materially by any such method. Undoubtedly there are serious limitations now to the possibility of desired accomplishment—limitations which the suggested plan might overcome to a great extent. The history of the administration of the Hatch and Morrill funds under the department of agriculture encourages the belief that revolutionary results might be expected to follow the judicious institution of similar bounties with more general application to primary and secondary education. And the reactionary influence of this same agricultural department upon the school systems of rural districts is a telling argument indeed. We certainly have no quarrel with the advocates of a strong department of education at Washington.

What the present writer aims to emphasize here is the paramount importance of more closely relating the general public to the school system. Dr. Moore asks with feeling born of bitter experience (but crowned with fresh laurels of victory won in this very controversy): "Shall the city board of education fix the amount of money required for school purposes each year, or shall the

[1] October 8, 1909, p. 470.

most corrupt and most inefficient of American institutions, the city government, do it?" Probably the querist is not aware of the form in which the question might have been as aptly put some years ago by a worthy predecessor in the same position in the same city of Los Angeles, and with the same feeling born of equivalent experience, but with tables turned. There was a time here when "the most corrupt and most inefficient of American institutions" was the board of education itself. And the present so-called "non-partisan" board, honorable and capable and efficient as it is, must be regarded, *in toto,* as almost unique among the boards of its class in this city. There was a plenty of vicious candidates to run against these men; and there would be many now of self-seeking politicians, if the people had not at last awakened and come into their own.

This, then, is the conclusion of the whole matter. There is no process or method or subterfuge, no manner of means whereby the lifeblood of the common school system may be kept pure and wholesome, save in the healthy growth and expression of public sentiment. No politician can withstand this weapon and no unworthy person can secure the power to harm, if all who love and revere the true spirit of American institutions will simply recognize their own relations to the schools when they cast their votes. With good officers in place, it matters very little what body politic assigns the funds; it will be well done by either one. With bad men in power, it matters not, likewise; for no good can come of it, anyway. As a matter of business wisdom, the authorities most closely in touch with the needs of the school ought to be given the most extensive powers relating thereto. But, with efficient public servants, the best possible arrangement is one which throws the initiative power and responsibility upon the general in direct command. The least possible interference consistent with resources and environment makes for the greatest economy and efficiency in the end. Boards of education, city councils and similar representative bodies should be mainly counsellors and legislators, and the bestowal of patronage should be beyond their reach.

One peculiar feature of our school system is positively ridiculous when thoughtfully considered. This is the eligibility of the notoriously ignorant to positions demanding knowledge. A man unable to read or write may readily acquire power to decide upon the teaching of reading and writing. Educational qualifications are demanded of teachers, and now of public servants in most positions of the most ordinary importance, outside of educational boards of control. There can be no field where lack of such a requirement is more lamentable than in school supervision.

The vast influence of the National Educational Association in harmonizing and adjusting the diversity arising from varying state and local systems amply justifies the hope that a more concentrated and authoritative department of the government, well supported, as are other more narrow and more clannish interests, might accomplish far more than can be predicted in set terms. And the greatest of its aims should be to collect, arrange and disseminate accurate information regarding all phases of educational problems. The department of agriculture, ably conducted, has not only built up a cult of investigators, but in connection with the training of these, it has revolutionized agricultural education in the whole United States; and these important results to the rural districts are far more already than has been accomplished by all the worthy work of mere educators and their machinery in the same field. Educational experiment stations, sorely needed, have failed for lack of support. Agricultural experiment stations, fostered by a government department, have waxed strong and forced their way to recognition and reputation among the farming communities. We need strong support for like investigations in human culture.

For the crime, disease and ignorance of this generation, history is responsible, all credit for slow and sure amelioration being likewise credited to the account. For what remains after us to clog the veins of humanity, we must

be held more blamable by reason of our better realization of the remedies available.

THEO. B. COMSTOCK

LOS ANGELES, CAL.,
October 15, 1909

INTERNATIONAL LANGUAGE

TO THE EDITOR OF SCIENCE: In SCIENCE for October 22 Mr. J. D. Hailman has set forth with admirable clearness some of the reasons why scientists should adopt an artificial international language. Your readers will be interested to know that the whole question has recently been thoroughly discussed in a book called "Weltsprache und Wissenschaft," published by Fischer in Jena. This book, which is in itself an interesting sign of the internationality of present-day science, written as it is by five university professors belonging to five different countries: Couturat (France), Jespersen (Denmark), Lorenz (Switzerland), Ostwald (Germany) and Pfaundler (Austria), contains also an account of the most recent development of the international language movement, with which Mr. Hailman does not seem to be familiar and which you will therefore allow me to sum up here.

In October, 1907, an international scientific committee, elected by some 300 societies of various countries and presided over by the famous chemist Ostwald, met in Paris to decide which of the many proposed artificial languages would be best for international communications. After a careful investigation of Esperanto, Neutral, Universal, Novilatin, Langue Bleue and several other systems, the result was unanimously arrived at that none of these languages was quite good enough, but that Esperanto might serve as a basis, provided it were thoroughly modified and improved on certain specially indicated points. A smaller committee was selected to work out the details of this language, which is now before the public in the shape of dictionaries, grammars and readers in eight or nine different languages; the English ones may be had at Brentano's, New York. In spite of the short time this interlanguage (generally called Ido) has existed, it has already gained a great many adherents among Esperantists as well as among those who had been deterred by many of the forbidding features of that language. Propaganda clubs have sprung up in a great many cities, some old Esperanto periodicals have adopted the new language, and new periodicals have come into existence, while a duly elected academy has charge of the further development of the language.

This may be described as a purified Esperanto, freed from all the arbitrary word-coinages and word-clippings of that language, freed also from its illogical and insufficient rules of word-formation, and last, but not least, from its clumsy alphabet with circumflexes over *c, s, g* and other letters. (Fancy an international language that can neither be telegraphed, nor printed in every printing office!) From another point of view Ido may be described as a systematic turning to account of everything that is already international in words, derivative endings, etc. Every one can easily master such a language because it is nothing but what has well been termed the "quintessence of European languages." A few lines will enable the reader to compare Esperanto and Ido and to judge for himself with regard to their general character. (In the Esperanto specimen the circumflexed letters have been printed as *ch, sh,* etc., according to a practise allowed by Dr. Zamenhof.)

ESPERANTO

Kiam chiuj tiuj, kiuj volas la sukceson de la lingvo internacia, konos chiujn kondichojn de la problemo, tiam oni konstatos, ke malgrau siaj bonaj ecoj, Esperanto devas ricevi shanghojn, char mankas en ghi multaj radikoj, ne sole por la sciencoj, la artoj, la profesioj, sed ech por la simplaj bezonoj kaj ideoj de la vivo ordinara.

IDO

Kande omni ti qui volas la suceso di la linguo internaciona, konocos omna kondicioni di l' problemo, lor on konstatos ke malgre sa bona qualesi Esperanto devas ricevar chanji, pro ke mankas en ol multa radiki, ne sole por la cienci, la arti, la profesioni, ma mem por la simpla bezoni ed idei di la vivo ordinara.

OTTO JESPERSEN,
Exchange professor,
Columbia University

OXYGEN AS WELL AS WATER PROVED TO EXIST IN THE ATMOSPHERE OF MARS

In Science for January 29, 1909, I announced that I had determined the amount of water vapor in the atmosphere of Mars by quantitative measurements of the relative intensification of little *a* in its spectrum, as exhibited in the Mars-moon spectrograms taken by Dr. Slipher at the Lowell Observatory. Through the kindness of Dr. Lowell, I have been enabled to continue the examination of these plates, and with improved facilities, I am now able to add the definite establishment of a relative intensification of the oxygen bands in the spectrum of Mars.

In my previous communication, an earlier paper in the *Philosophical Magazine* was referred to, but not quoted, in which I ascribed Dr. Slipher's success to his having made use "not of the comparatively feeble 'rain-band' near *D* which has been the subject of much contention in the past, but of the much more powerful water-vapor band '*a*' in the extreme red." This might be interpreted as meaning that though little *a* is intensified in the spectrum of Mars, the rain-band near *D* is unaffected, although I had no intention of making such an assertion. Dr. Slipher did, indeed, say that "the spectrum of Mars shows no selective absorption not found in that of the moon photographed under the same conditions";[1] but his obvious meaning is that other Martian absorption bands, though doubtless present on these plates, are too feeble to be certainly distinguished in the presence of telluric bands of the same wavelength. I should say the same myself of any *immediately* apparent intensification of the rain-band or of the oxygen bands in the spectrum of Mars; but it is well known that by sufficiently delicate methods, and by taking the average of a large number of observations, almost vanishingly small quantities can be evaluated. The reliability of the measurement must be tested by its probable error, and by a thorough investigation of the possible sources of error. I have now made such an investigation of the relative intensity of great *B* in the spectra of Mars and the moon at equal altitudes, and find that *B* in Mars is more intense by an amount eight times as great as the probable error, thus confirming the existence of oxygen in the atmosphere of the planet. Lowell Observatory Bulletin No. 41 may be consulted for the details of the observation.

In Science for March 26, 1909 (p. 500), Professor Campbell reproves me for not knowing that "*the effects of oxygen and water vapor on Mars were no more visible in the region* λ *5400*–λ *6900 of the spectrum than were the effects of oxygen and water vapor existing on the moon!*" (Italics and exclamation point are Professor Campbell's.) The reason why I did not mention facts which Professor Campbell considers so obvious as to require only his statement to prove them, is that I already had evidence at that time that great *B* (λ 6867) is more intense in Mars; but because the probable error of the measurement with the apparatus then used was large, I waited until improved apparatus and more reliable results could be obtained before making the announcement.

Eight entirely independent series of measures were made on four plates, each containing three spectrograms. No computations were made until after the last measurement had been completed, and I had no knowledge whatever of the significance of the result until the computations were finished. Since every one of the eight series gave a positive result, and since the method was so guarded as to eliminate every source of possible error which is known to me, I have no hesitation in announcing the intensification of great *B* in the spectrum of Mars as a fact. Nevertheless, I must warn any one who seeks to repeat the observation that its verification will demand exceptional facilities, a long apprenticeship in the art of delicate photometric comparisons, and a good deal of patience and persistence. The measurement is much more difficult than the by no means easy one of the intensification of the little *a* band of water vapor in Mars. In illustration of the difficulty of the

[1] *Astrophysical Journal*, 28, p. 403, December, 1908.

latter observation, I may say that in trying to demonstrate it to visitors, the first objection is apt to be, "but I don't see any band." When, after some coaching, the faint hazy band is seen, the next assertion is usually that there is no difference in its intensity in different spectra; and it is hopeless to expect a verification of the delicate quantitative measurement, unless the would-be observer can acquire the requisite skill. It is important that the spectrograms of the water-vapor band shall be secured when the water vapor in the *total* terrestrial air column is in smallest quantity. A low dew-point at the earth's surface does not guarantee this condition, which, in general, is almost never present in summer. For this reason the spectroscopic data should be obtained in winter.

FRANK W. VERY

WESTWOOD, MASS.,
October 1, 1909

QUOTATIONS

THE HARVARD MEDICAL SCHOOL AND HARVARD COLLEGE

THE modern tendency to align medicine with the other professions as a graduate topic is a sound as well as an irresistible tendency. But we think that some authorities have fallen into a logical error in attempting to buckle end-to-end, in the required training of a physician, the present college curriculum, and the medical curriculum as it grew up in pre-university days. The courses provided by medical schools comprise many which afford a high type of culture looked at from any standard. He would be exceedingly narrow who should deny that many of the courses which are indispensable ingredients of a medical education are also essentially academic, and worthy components of anybody's education. We go so far as to regard practically all the studies of the first year and a half of the Harvard Medical School as in posse, if not in esse, studies of an academic rank, as cultural studies. In brief, we desire to see them, while maintaining their indispensable rôle in medical education, open to all persons who have any hygienic aims or any anthropological interests.

We would not "let down the bars" to all who might care to wander about in medicine unguided. We should throw proper restrictions about these courses, such as are thrown about all other advanced courses by the faculty of arts and sciences. But we should offer, to be taken and counted toward the bachelor's degree under proper precautions, all these courses. Let us admit to them any persons who wish to study the fundamental facts of health and disease amongst all the other economic, sociological or anthropological facts which to-day make up the proper study of mankind.

By this device we should destroy forthwith the familiar bugbear of "counting twice" certain studies, under the "combined A.B. system," toward both A.B. and M.D. For we regard the diagnostic and therapeutic courses of the medical school as the essentially medical courses, and the other so-called fundamental courses as not merely medical, but in a broad sense biological. We consequently see no objection to including such courses in work for a bachelor's degree, though we foresee hesitation on the part of some of those who grew up when the medical school was virtually independent of the university, to acknowledge the sources of some of their own culture.

We deny categorically the danger of undue specialization in this field and have above called attention to some random examples of greater specialization by persons who later won their doctorates in other fields.

We insist that our plans, if carried out, would encourage academic freedom and would be in line with all that is good in the elective system. In fact, so harmonious are these ideas with the university system as it otherwise stands that we can lay claim to no originality whatever in the advocacy of our plans. In short, we ask for nothing more than a logical application to medical studies of principles which have long successfully governed the graduate school of arts and sciences.

In this event, some men would receive the

degree of doctor of medicine after about six years of university residence, to which, however, there must be added at least a year of hospital work, and these men, like many doctors of philosophy, would have a rather narrow education. Such an education is, however, less narrow than that of many Harvard doctors of philosophy, under our present system. Others would devote eight or even nine years to their university careers, and their training would be correspondingly broader. Surely there is room at the Harvard Medical School for these different classes of students. But, in any event, the six-year men can be excluded only by an act which will inevitably cut us off from an important and rapidly growing group of American institutions, the great middle western and western state universities. We may not need the numbers thus lost; surely we should not lose their influence, if we are to be national and not local in scope.

As we believe, the greatest of all the needs of the Harvard Medical School is free, and, so far as possible, untrammelled intercourse with every other department of Harvard and with every other American university. No small changes are necessary if our medical education is to be made thus elastic, but surely it can not injure Harvard College to broaden the elective pamphlet by the introduction of suitable courses, nor can it hurt the Harvard Medical School to broaden its scheme of admission, to bring itself into relation with American universities in general, and into correspondence with the Harvard Graduate School, if this be done without diminishing the requirements for the degree of doctor of medicine.

These results may be accomplished by the following arrangements:

1. Count towards the A.B. suitable courses in medical sciences. 2. Admit unconditionally to the medical school all holders of a respectable bachelor's degree. 3. Grant the M.D. (*a*) after not less than a fixed minimum of residence; (*b*) upon evidence of theoretical and practical attainment in the medical sciences (including the present admission requirements) and in the clinical branches. 4. Establish a simple administrative mechanism for the degree of M.D., modelled after the present mechanism for the Ph.D. 5. Execute the above arrangements in the broadest spirit, to establish and preserve academic freedom, as exemplified in the greatest variety of preparation, of medical course, and of finished product. 6. Relax the present rigid organization of the medical school curriculum and lay stress upon the quality of our doctorate rather than the means of its attainment. 7. In all ways encourage the better students. Permit them to advance at their own rate and in their chosen paths.—*The Harvard Bulletin.*

SCIENTIFIC BOOKS

Life and Letters of Peter and Susan Lesley. Edited by their daughter, MARY LESLEY AMES. In two volumes. Pp. ix + 526, 562, New York, G. P. Putnam's Sons.

The founders of American geology are only names to most of the living. Not one remains of those who were engaged on the surveys of 1836 to 1841 and only one survives of those who shared in the Pacific Railroad surveys. Tradition relates that many of the early geologists were mighty men; the record of their work and of their warfare has been transmitted to us, but, for the most part, their personality is unknown. Obituary notices, presented in societies, usually discuss only the value of the subject's scientific work and leave the reader anxious to learn something of the man. No such defect is present in these volumes, for here is revealed Professor Lesley[1] as he knew himself and as his friends knew him.

Peter Lesley's father, third of the name, was born in Philadelphia, son of a revolutionary soldier, who, coming from Scotland, had established himself in that city as cabinet-maker. Just as Peter third was about to enter the university, his father died and the young man was compelled to take the father's business in order to support the family. In

[1] Professor Lesley was always dissatisfied with his name and when he became of age he placed the "Jr." as a prefix instead of suffix; thenceforward he was known as J. P. Lesley.

due time he took to wife the daughter of John Allen, a woman of sprightly mind and artistic temperament, with, like himself, strong religious convictions. (J.) Peter, the eldest son, was born in 1819.

Ninety years ago, parents were not afflicted as now with grievous anxiety respecting the health of their children, and boys, especially eldest sons, found themselves scaling the heights of Parnassus at a tender age. Young Peter was sent to the best school in Philadelphia, where he applied himself so well that when eight years old he gained the prize for an examination in Bonnycastle's algebra. At home, the father drilled his children in geography, mechanics, literature, statistics and above all in the accurate use of language, so that Lesley could well say in later years:

He started us in our careers equipped for seeing, thinking and describing what we felt to be useful and beautiful as what we believed to be true.

Professor Lesley was a nervous, excitable youth and his health gave way frequently, but then, as in after life, he exhibited remarkable recuperative power. After many interruptions, he was graduated from the University of Pennsylvania in 1838 but with health so broken that he could not begin study for the ministry, as he had intended. By advice of Dr. Dallas Bache, he sought and obtained from Professor H. D. Rogers the position of assistant on the geological survey, which he retained until the close of the work in 1841. The letters during this period show the strange combination of temperaments which made him so delightful a companion in later years. The keen observer of actual conditions and the impressionist artist struggle for supremacy, while at times a philosopher of medieval type bursts in with abstruse discussions. A curious grouping in a lad of twenty, which gives to his letters an incomparable charm. These letters tell much of his associates on the survey; one shows that geologists then had the same burden as now:

I got a lecture on geology from W[helpley], who complains bitterly that the landscape is ruined to him because he looks down on a valley and can't help saying, there's No. 7—that next hill is No. 6, etc. In fact geology destroys all poetry and one can not be an Arcadian, as long as he knows what formation he's standing on and what one he is looking at.

The survey came to an end, Lesley entered Princeton Seminary, graduated in 1844, was licensed to preach and went to Europe to make a pedestrian tour. Returning, he spent two years as colporteur among the Pennsylvania-Germans and then went to Boston to complete the Pennsylvania geological map for Rogers. In 1848 he assumed the pastorate of a congregational church at Milton, Mass., and early in the following year he married Susan Inches, daughter of Judge Lyman, of Northampton, Mass.

According to all accounts, the young couple began married life with very little to encourage their friends. They had bad prospect of health and worse prospect of pecuniary support, for Lesley's position as clergyman was precarious, owing to his theological views. They were wholly contrasted in temperament; she calm and loving quiet, he restless and loving excitement. But their friends erred. The marriage in 1849 was the beginning of an ideal life, which ended only with his death in 1903. They lived happily in Milton for three years amid most attractive surroundings. The letters during this period show how broad their social relations were, for they tell of Channing, Desor, J. Freeman Clarke, Lesquereux, Edward Everett Hale, Agassiz, Emerson, Lyell and a host of others in science, literature and theology, who were entertained in the hospitable little house at Milton.

In 1852 Lesley entered the employ of the Pennsylvania Railroad Company with his office in Philadelphia, and in August of that year the young couple removed to that city, where for forty-one years they were increasingly influential. He soon became secretary of the Iron Masters' Association and librarian of the American Philosophical Society. In 1863, the railroad company sent him to Europe to study methods of hardening the surface of rails and to investigate the Bessemer process. During a stay of three months he found opportunity to renew old acquaint-

ances and to make many new ones and his letters give interesting glimpses of the men. Here is one on Lyell:

I must tell one of Sir H. Holland's jokes on Lyell. He saw him running across the street to him one day saying, "Have you heard the news?" "No is Lucknow relieved?" "Oh, I don't know anything about Lucknow—but haven't you heard that we have just got another new marsupial from the dirt-bed at Lyme?" I find Lyell just as nervous as ever—more so in fact—and far more interesting.

In 1866, after a year of tremendous work as expert, his health gave way and he was compelled to go abroad, where with Mrs. Lesley he spent twenty months, wandering as far as Palestine and the Nile. They returned to Philadelphia in 1868 and soon afterwards occupied the home on Clinton St., where they remained until 1893, when his final break came and necessitated removal to their house at Milton. With this return to Philadelphia, there began another period of incessant activity. The danger of poverty, prophesied by their friends, had passed away many years before, but Lesley's appetite for work was insatiable. Mrs. Lesley was scarcely less active in her sphere of organized philanthropy, to which her letters make only incidental references. Mrs. Ames has done well in supplementing them.

The life in Clinton Street is common property, for that house was a Mecca to which all scientific men turned when in Philadelphia, assured of a welcome which would make them think better of their kind. The story has been told so often that it need not be repeated here.

Any notice of this work, brought within reasonable compass, must be only a patchwork of fragments, giving no proper conception of its importance. The long unreserved letters, covering the period from 1838 to 1893, concern not the writers alone; they tell of men and women who have graven their names deeply in science, literature and even in politics; they throw interesting sidelights upon many obscure matters in our country's history, for the Lesleys were associated intimately with many who were leaders in great movements. Mrs. Ames has woven the material so skilfully that Peter and Susan Lesley tell their own story and that of their time. The volumes contain numerous portraits, the last of which is copied from a painting made by their daughter, Mrs. Bush-Brown, not long before they passed away. Professor Lesley, old, feeble, yet cheerfully content, sits with one hand resting on the shoulder of Mrs. Lesley, who still retains the beauty of feature and expression which had endeared her to all acquaintances. The scene is the fulfilment of a prophecy made by Lesley almost fifty years before:

I half believe that when I am an old decrepit man, sitting all day in a well-worn armchair, my volatile and restless nature fixed like carbonic acid into a solid, snow-like equanimity, she will be briskly moving about me like a bright planet around a gone-out sun, and returning to me the little borrowed light and heat that I have ever been so happy as to give her.

Professor Lesley passed away in June, 1903; Mrs. Lesley survived him, but she faded away gradually, until the following January death came to her also. "They were lovely and pleasant in their lives and in their death they were not divided."

John J. Stevenson

The Cambridge Natural History. Edited by Harmer and Shipley. Vol. IV. Crustacea and Arachnida. 8vo; pp. xviii + 566; 287 figures. London, Macmillan & Co. 1909. $4.25.

This volume completes the set of ten of the Cambridge Natural History, and the editors are to be congratulated upon bringing to completion such a comprehensive work, one that exhibits so many excellencies and has been of such great service as a reference work to zoologists.

The delay in the publication of this last volume is due to the death of Professor Weldon, "who had undertaken to write the Section on the Crustacea"; he, however, completed only the chapter on Branchiopoda, while the remainder of the group has been written by Mr. Geoffrey Smith. The Crustacea occupy 217 pages. Chapter I. treats of

their general organization, with special treatment of the segmentation, appendages, body cavity and nephridia, alimentary, reproductive and respiratory organs. The nervous system is entirely omitted, also the musculature and moulting phenomena, and the treatment of the nephridia is rather superficial and not illustrated by figures. The second chapter, on the Branchiopoda, is by far the best on any section of the Crustacea, contains many new figures and unpublished observations on the habits, and terminates with useful keys for the identification of all genera of the Phyllopoda and all British genera of the Cladocera. The remaining chapters contain few new illustrations. Chapter III. deals with the Copepoda, IV. with the Cirripedia and Ostracoda (to the latter is devoted only a little over two pages), and Chapters V. and VI. with the Malacostraca. The parasite *Sacculina* is well treated, with interesting new observations. Parasitic castration is considered, also partial and temporary hermaphroditism (these terms are rather objectionable) and normal hermaphroditism. Phosphorescent organs are interestingly described, but in connection with the compound eyes no mention is made of the work of G. H. Parker. The remainder of the treatment is mainly taxonomic. Chapter VII. deals with the geographical distribution of the group, including the relations of fresh-water and marine faunæ, and the author accepts the view of Ortmann, for which there is now so much evidence, of an original land connection between the continents of the southern hemisphere. While the section on the Crustacea is clearly written, many important morphological phenomena are either omitted or mentioned most briefly.

The Trilobita are very well treated by Henry Woods in 31 pages, about two thirds of the account being devoted to their structure.

Professor Shipley gives in the brief Chapter IX. an introduction to the Arachnida, essentially in agreement with the views of Lankester. He subdivides the Arachnida into the Delobranchiata (though there is no good reason why this should replace the better known Merostomata), and Embolobranchiata; the former includes the Xiphosura and Eurypterida, the latter the Scorpionidea, Pedipalpi, Araneæ, Palpgradia, Solifugæ, Chernetidæ, Podogona, Phalangidea and Acarina. He places the Tardigrada and Pentastomida as "appendices" to the Arachnida.

The Xiphosura are also treated by Shipley, in 21 pages. He follows Lankester in making the eye segment the first, the rostral the second and the cheliceral the third. There is no good description of the eyes or discussion of their homologies, and no figures of them, so that the treatment is decidedly scant, especially in comparison with that given by Korschelt and Heider in their "Lehrbuch."

The Eurypterida are well described by Henry Woods in 12 pages, with good figures from the best restorations.

Cecil Warburton has written the accounts of the remaining arachnidan groups, the Embolobranchiata, and his treatment is a useful contribution, for this is the fullest text-book account yet given of these groups. The best part is the biological and taxonomic, for not much attention is given to the internal anatomy and almost none to the embryology. All the taxonomic families are characterized, though not in the form of analytic keys.

To the Scorpionidea are devoted 12 pages, with the internal anatomy given most briefly; to the Pedipalpi, 5 pages; to the Palpigradi, 2 pages; to the Solifugæ, 7 pages; to the Chernetidæ, 9 pages, with a list of all British species; to the Podogora (Ricinulei), 2 pages; to the Phalangida, 15 pages, a good treatment. In the greater number of text-books the preceding groups, with the exception of the scorpions and solifugids, receive only the barest mention. The large group of the Acarina is treated in 20 pages, too briefly.

The fullest attention is given, however, to the Araneæ or spiders, more than a hundred pages being occupied with this group. There is a good description of the external anatomy and the stridulating organs. But the internal anatomy is too briefly treated, the colulus and various salivary glands are entirely omitted, also the entapophyses, the endosternal structures (a most serious omission) and the

musculature. The author also fails to cite certain important memoirs, such as Gaubert on the lyriform organs, Wagner on the auditory hairs and moult, Lamy on the respiratory organs, and Menge on copulation and sperm transfer. The treatment of the habits (46 pp.) is excellent on the whole, for here Mr. Warburton is much more in his element, though few literature references are given; there is considered the moulting, behavior of the newly-hatched, architecture (especially good on the orbicular nares), poison, fertility, natural enemies, protective coloration and mimicry (at places these two are confused, and also the latter with aggressive coloration), the senses, intelligence and mating habits. With regard to hearing he concludes: "If there be any true hearing organ in spiders its location is quite uncertain"; it is strange he does not even refer to the work of Wagner, Dahl and Pritchett. Chapter XV., 38 pp., is the taxonomic treatment of all the aranead families, with notes on habits and distribution, the classification adopted being that of Simon; only a few of the families are illustrated by figures.

The chapter on the Tardigrada, 11 pages, by Shipley is excellent. He concludes "there can be no doubt that the Tardigrades show more marked affinities to the arthropods than to any other group of the animal kingdom," which is well in accord with our present knowledge. Shipley also contributes a brief but good chapter on the Pentastomida.

In 42 pages the Pycnogonida are well considered by D'Arcy Thompson, with a good account of the structure. There is an excellent figure of the male of *Boreonymphon* carrying the young. All the families are described. As to the genetic affinities he believes "that such resemblances as the Pycnogons seem to show are not with the lower arachnids but with the higher; they are either degenerates from very advanced and specialized Arachnida, or they are lower than the lowest. Confronted with such an issue, we can not but conclude to let the Pycnogons stand apart, an independent group of Arthropods."

We can say of this volume that what is given is given fairly well, the errors are mostly of omission. The most serious omission is the lack of description of the embryology, for in certain of the groups no mention at all is made of the development, and in others nothing except a few larval stages are described. The reader might be led to believe that many of these animals do not have ontogenies! It may be fairly asked, how can any one form a good concept of an animal's structure without a knowledge of its development? At least short résumés of the ontogenies should have been presented. It also occurs to the reviewer that it would have been much better to have devoted two volumes to the groups treated in this one, just as two volumes have been given to the insects. Had this been done, the treatment of each group could have been much more comprehensive, the errors of omission avoided, and the work thus made much more valuable for reference.

Great praise is certainly due to the chapters on the Arachnids, for they help to fill a long-felt want; this group has always received scanty treatment in text-books, and the larger works are not accessible to most students. From most text-book accounts one would gather that the Arachnids are mostly scorpions! It is to be hoped that this last volume of the Cambridge Natural History will arouse wide interest in the group of the spiders, so interesting in structural specialization and instincts, and will lead, in our teaching, to the supplanting of the alcoholic scorpion by the living spider. And it is also hoped it will stimulate more students to investigate those neglected aberrant groups, the tardigrades, pentastomids and mites.

THOS H. MONTGOMERY, JR.

SCIENTIFIC JOURNALS AND ARTICLES

Internationale Revue der gesamten Hydrobiologie und Hydrographie. Unter Mitwirkung von ALBERT, FURST VON MONACO, ALEXANDER AGASSIZ, CARL CHUN, F. A. FOREL, VIKTOR HENSEN, RICHARD HERTWIG, SIR JOHN MURRAY, FRITJOF NANSEN, OTTO PETTERSSON und AUG. WEISMANN. Herausgegeben von BJORN HELLAND-HANSEN

(Bergen), GEORGE KARSTEN (Halle), ALBRECHT PENCK (Berlin), CARL WESENBERG-LUND (Hilleröd), RICHARD WOLTERECK (Leipzig) und FRIEDRICH ZSCHOKKE (Basel). Redigiert von R. Woltereck. Bd. I., XXII., 900, 76 pp., 21 Taf. Leipzig, Verlag Dr. W. Klinkhardt; New York, G. E. Stechert. 1909. M. 30.

The past ten years have witnessed the origin of more than a score of new journals or serials of a periodical nature, primarily with zoological contents or including zoology as one of their main fields. Some of these are the organs of institutions of research or of societies of investigators, new and old. Others owe their origin to single investigators or their schools, and still others are the logical outcome of the increasing tendency to specialization and represent particular fields of research. The journal in hand, which is now in its second volume, owes its origin in part to the last-named cause, but even more to a movement in the opposite direction of generalization based upon the cooperation of investigators and coordination of results in the different sciences concerned in the causal analysis of the problems of the biology of fresh waters and of the sea. Investigators in these fields of marine and fresh-water biology in which the sciences of botany, zoology, bacteriology, chemistry, physics, hydrography and physical geography are all intimately concerned, have long felt the need of a common journal or clearing house where all results bearing on the biological aspects of these problems may be published and where comprehensive reviews written from the standpoint of hydrobiology and an up-to-date bibliography might be found with more convenience, completeness and certainty than in scattered journals in these diverse sciences. The *Revue* bids fair to meet this need and to afford a most acceptable and efficient organ for the coordination of these several sciences by keeping each separate branch of study in constant touch with the advances made in all other departments, and to render effective service in extending and stimulating work in its field.

The international character of the journal is sufficiently indicated by the list of coadjutors, editors and contributors and the comprehensiveness of its scope is attested by its program, which appears in full in the "Prospekt," issued in 1908, which forms the introduction to the volume.

Above all, the editors recognize the necessity of a synthesis of our biological and hydrographic-geological knowledge of the waters. These two spheres of investigation are inseparable; since the water, whether as river, lake or sea, is never a factor in the shaping of the earth without being also a medium of life, and on the other hand, is never a medium for life without at the same time having an important influence in the shaping of the earth's surface.

As the biology of the waters has now passed from the description of what is found therein into the causes and origins of the animal and plant life and the phenomena accompanying it, the absolute necessity has arisen for the biologist to really understand the nature of the separate waters, their physics and chemistry as well as their form and the history of their bed.

On the other hand, with the advance of marine and fresh-water investigations (in brief, the study of the waters), it has also become necessary for the hydrographer and geologist to understand something of the biological factors, which are operative in the physico-chemical changes of the water as also in the formation of coasts, land and deposits.

The editors justify the inclusion of both fresh-water and marine fields in the same serial on the ground that a synthesis of results in the two is desirable because of their common, overlapping, or interdependent problems. They also express the hope "to bring into existence a helpful synthesis of the results obtained by the pure sciences and the practical or applied sciences."

Of the nearly 1,100 pages in the volume, 523 are given to original articles, usually upon topics of more general interest, 180 to summaries and critical reports, 80 to bibliographies and the remainder to short notices on scientific matters, on biological stations, expeditions, surveys and university courses in the field of the journal.

As might be expected from the composition of the board of editors the contents of the *Revue* are primarily zoological, only a single purely botanical title appearing in the list of original articles and but five in the field of hydrography. Noteworthy among these is a prodromus for a renewed attack with the "Fram" upon the problem of the North Polar Basin by Raould Amundsen. There is also a predominance of fresh-water subjects (16) over those (5) from marine fields which is in part due to the editor's relationship to the new fresh-water station at Lunz in the Austrian Alps, and to the further fact that many investigators in the marine field are connected with the various branches of the International Commission for the Investigation of the Sea or other governmental or institutional enterprise of a similar sort having their own mediums for publication. Among the original articles of a general character are a Hydrobiological introduction by Professor Weismann in the closing words of which he reaffirms his adherence to the Darwinian point of view as to the efficacy of minute variations as over against mutations in the process of evolution. A second introductory article by Dr. John Murray on "The Distribution of Organisms in the Hydrosphere as affected by Varying Chemical and Physical Conditions" is a statement of problems and results in marine biology in the light of recent investigations in oceanography and limnology. Professor Richard Hertwig discusses the function of the fresh-water biological station in present-day research and Professor Issel contributes a general article on the biology of hot springs. Two pages of unusual general interest are those of Lohmann on the relation between pelagic deposits and the plankton of the sea and of Nathansohn and Gran on the general conditions of production in the sea.

Intensive work, on the other hand, is represented by Dr. Gotzinger's carefully wrought out limnological monograph on the Lunzer Mittersee, by Klausener's studies on the "blood lakes" of the high Alps, by Kratzschmar's experimental analysis of the polymorphism of *Anuræa aculeata* and by Professor Fischel's elaborate studies of the intra-vitam staining of *Daphnia* in which the success of the new intra-vitam stain alazarin is shown. The "Sammelberichte" constitute one of the most useful parts of the journal. They deal with a wide range of subjects, from Brehm's article on the geographical distribution of copepods and their relation to the ice age to Steche's compressed summary of our present-day knowledge of *Hydra* and Franz's review of the latest results in the study of the migrations of fishes in the North and Baltic seas, and his discussion of the economic significance of recent discoveries in the life history of the eel. Of especial service are the authentic summaries of the work of various surveys and explorations, such as Collet's and Scourfield's accounts of the hydrographical, geological and biological results of the all too little known work of the Scottish Lake Survey, Cori's description of the work of the Adria Verein at Trieste, Entz's summary of the Balaton Lake investigations in Hungary, Juday's résumé of the exploration of the Wisconsin Natural History Survey, Zschokke's note on the results of the investigations of high alpine waters and Zuelzer's review of the recent work in Germany upon the biology of polluted waters, a subject deserving wider attention in our own country.

Notices (often illustrated) of the biological stations at Port Erin, Roscoff, San Diego, Monaco, Lunz, Plön, Sebastopol, of instruction in oceanography and related subjects in universities, of congresses, expeditions, etc., find a fitting place in the several "Hefte" of the *Revue*.

The original prospectus included a project for a continuous index of papers received and annual summaries of the year's production in the whole "science of waters." The first part of this program was wisely dropped with the issue of the first Heft, and the second obviously could hardly be completed in 1908. The difficulties which beset even the best organized and longest established "Jahresberichte" in the more centralized fields of research can only be adequately appreciated by those who perform the thankless drudgery of their preparation. In the diffuse field of hydro-

biology how much more difficult the organization and prompt completion of annual summaries requiring, as these do, the cooperation of specialists in less closely associated subjects! Nevertheless Professor Woltereck and his associates have undertaken the seeming impossible and Bd. I. contains as a supplement the first section of the Jahresübersicht for 1908 including: I., Limnography; II., oceanography; III., fresh-water botany; IV., marine botany; V., applied hydrobiology (polluted waters and water supplies); VI., fresh-water zoology (excluding vertebrata). The remaining parts (with Nachträge to those above named) will be issued in the current year. These are VII., marine zoology (excluding vertebrata); VIII., marine and fresh-water fisheries with supplement on "Aquariumkunde"; IX., potamology, moorkunde, thermal and cave waters.

Obviously a considerable part of this field (III., IV., VI. and VII.) is already covered in the long-established botanical and zoological summaries and bibliographies, but all too often imperfectly and not from the standpoint of hydrobiology. The other fields are sorely in need of just such summaries and bibliography as are here projected. Every worker in these fields should help on the project of securing complete and prompt representation of the literature by providing the *Revue* with reprints or notices of his work. Naturally there are many deficiencies in the parts now published, but they are to be expected in the initial stages of all such enterprises. The bibliography and summaries of literature form a supplement with independent pagination.

The new *Revue* should receive the cordial support and cooperation of all who are interested in the manifold phases of hydrobiology, whether descriptive, experimental or applied.

Charles A. Kofoid
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THE TREATMENT OF CERTAIN TICK-TRANSMITTED DISEASES.

Ever since the discovery of the destructive effect of quinine on the causative organisms of malaria, investigators have dreamed of the possibility of discovering similar therapeutic agents for use in other diseases caused by blood-infesting organisms. A recent paper by Messrs. Nuttall and Hadwen,[1] dealing with experiments conducted at the University of Cambridge, seems to indicate that drugs have been discovered which display the same destructive effect upon certain species of disease-causing species of *Piroplasma* as quinine has upon the organism of malaria.

There are four distinct diseases of domestic animals caused by as many species of *Piroplasma*.[2] Of these, splenetic or Texas fever occurs in various of the warmer parts of the earth and causes tremendous economic losses. Malignant jaundice of the dog occurs in India and South Africa and displays a very high lethality. Biliary fever of horses occurs in Africa, the loss is considerable. Carceag of sheep occurs in southern Europe and is considered an important disease. In all these diseases certain ticks have been found to be the agents of transmission.

In the experiments of Messrs. Nuttall and Hadwen the most remarkable results were obtained from the use of the stains known as trypanrot and trypanblau, in aqueous solutions injected subcutaneously. These were found to exert a direct and observable effect upon the

[1] Nuttall, J. H. F., and Hadwen, S., "The Successful Drug Treatment of Canine Piroplasmosis together with Observations upon the Effects of Drugs on *Piroplasma canis*," *Parasitology*, II., Nos. 1–2 (double number), pp. 156–191, July, 1909.

[2] In the literature the organism of the so-called Rhodesian fever of cattle is referred to as *Piroplasma parva*. However, Mr. Nuttall has pointed out that this species is not congeneric with those causing splenetic or Texas fever of cattle, malignant jaundice of dogs, biliary fever of horses and carceag of sheep. He has therefore erected the genus *Theileria* for the organism referred to as *Piroplasma parva*. This is especially interesting in view of the fact that the drugs which were found to have a most decided effect upon the true *Piroplasma* species did not exert any effect whatever on the parasite of Rhodesian fever.

parasites by causing the pyriform stages to disappear quickly and also to cause the total disappearance of the parasites from the peripheral blood. The action was most noticeable on the pyriform stage found in the plasma, which is exactly analogous to the action of quinine in malaria. However, the drugs apparently reached the stages within the corpuscles, causing them to show signs of degeneration. They presented a ragged and irregular appearance, quite different from the normal.

In the experiments with trypanblau ten dogs suffering with piroplasmosis were utilized. Failure to cure the disease resulted in only three out of the ten cases. In the failures distemper and other factors probably contributed to the death of the animals. This is especially likely in view of the effect noted upon the morphology of the organism in the microscopical examinations. In one case, which was repeated successfully, an injection of trypanblau twenty-four hours after inoculation prevented the appearance of the parasites in the blood of the dog which remained perfectly well.

In a note appended to the paper we are informed that trypanblau exerts a very prompt effect on the parasites of splenetic fever. This effect is precisely similar to that on the organism of the dog disease with which the experiments were primarily concerned. It is thus permissible to assume that the agents used by Messrs. Nuttall and Hadwen may be of use in the treatment of this very important disease, as well as in others caused by similar organisms. We are informed that the authors have interested the Colonial Office and the Department of Agriculture and Fisheries in extensive practical tests. We are promised reports upon this work and upon further laboratory experiments at an early date.

The writer commends the paper as one of far-reaching importance. Moreover, it is a model in the treatment of an intricate subject. Full details of experiments are given so that the reader knows exactly what are the bases for the conclusions drawn.

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SPECIAL ARTICLES

DEMONSTRATIONS WITH THE MUSICAL ARC

THE musical arc offers a convenient means of demonstrating many important features of electromagnetic theory. It may be of interest, therefore, to give a brief description of apparatus and methods, with references to some of the more elementary experiments which have been found helpful.

As is well known, the musical or "singing" arc[1] is obtained by connecting in parallel with the direct current arc a system containing self-induction and capacity. The arc used without this parallel or "secondary" system may be more or less unsteady, showing at the poles sudden change of potential difference of considerable magnitude. The secondary system may be thought of as supplying the conditions for taking up these fluctuations, and, in turn, emitting electric oscillations of frequencies determined in large part by the secondary itself. These oscillations, reacting on the arc, cause fairly regular interruptions in the discharge, which therefore emits a musical note. The pitch of this note may be varied by changing the conditions of the arc-circuit as well as by varying those of the secondary.

Examination by a revolving mirror and by the spectroscope seems to confirm what might from general considerations be expected in an arc of this kind, viz., that although the arc is interrupted, the poles give the distinctly different and characteristic forms of discharge observed in the continuous arc.[2]

For purposes of demonstration, good results may be obtained by using a condenser with capacity which may be varied from 1 to 10 microfarads and which is capable of standing a potential difference of 1,000 volts. The coil for the secondary may be made with three hundred turns of No. 15 annunciator wire wound on a spool of 10 cm. radius and 3 cm. axial length. The arc is perhaps most easily maintained between carbon poles. Examined

[1] Duddell, *Electrician*, 46, 1900. Simon, *Phys. Zeit.*, VII., 1906. Austin, *Bulletin of Bureau of Standards*, 3, No. 2, 1907.

[2] Vide *Astrophysical Journal*, XXVIII., No. 1, 1908.

in a revolving mirror, the musical arc shows serrations which are strongly marked near that pole which would be positive for the uninterrupted arc. Therefore to minimize the effects of convection as well as those due to wandering of the discharge over the terminals, and consequent change of pitch of the note, the poles should be about 8 mm. in diameter, vertical, and the positive one below.

With the above apparatus, the arc, after burning until the positive pole is sufficiently coned, may be made to give a clear note of tolerably uniform pitch and audible throughout a fairly large room.

Both pitch and intensity depend not only upon capacity, self-induction and resistance in the secondary, but also upon the potential difference of the arc terminals. High potentials give clearer tones, but the 110-v. circuit answers very well. For a given secondary, a slight adjustment of arc-length or of resistance in the arc-circuit may make a striking difference in the clearness and intensity of the note. Using the 110 V.D.C. mains, a current of 1.5 to 2.5 amperes is necessary. Too much current produces a hissing or an impure note, or even none at all. The fact that the tones may not be pure[3] does not interfere seriously with their use qualitatively as indicators of changes made in the various circuits employed. All connections should be very firmly made.

To show induced currents, incandescent bulbs may be used to advantage. Those of small resistance and for small potential difference are better, though of course easily burned out. Add to the above apparatus a few coils of various sizes, some metal plates, etc., and interesting demonstrations become at once possible. They depend on the change of pitch of the arc-note, or on the lighting up of incandescent lamps; these effects arising from modifications of the electrical conditions of secondary or tertiary circuits.

An obvious experiment is to vary the note by changes in the secondary, several octaves being easily obtained. This makes possible rough comparisons of self-inductions and of capacities for oscillatory currents, by comparing the arc-tones with those from tuning forks. The use of the ordinary formula, $2\pi\sqrt{LC}$ for the period of the discharge involves the assumption of its applicability, as well as the further one that the resistance may be neglected. It may readily be demonstrated that the latter is only approximately true.

The short-circuiting of the coil in the secondary produces a note the shrillness of which gives an instructive idea of the part played by inertia in an oscillating electrical system. An incandescent lamp may be made to light up by joining it with a coil laid on the one in the secondary circuit. Rotating and sliding the upper coil are modifications that suggest themselves at once. For oscillations of very high frequency, the bulb will not light up, since the heating effect varies inversely as the frequency, if the latter is high and the resistance is negligible. Placing a coil in open circuit on the one in the secondary produces no effect; but the result of closing the circuit of the upper coil is to raise the pitch of the note, the increased frequency of the oscillations arising from the decrease in effective self-induction in the oscillating system.

It is instructive to close the upper coil alternately through each of two equal resistances, one of which is non-inductive. The difference of pitch may be made very striking.

If two coils are used in series in the secondary, the effective loading of the oscillating circuit depends on the position of one coil relative to that of the other. The maximum inductance, and consequently the lowest note, is obtained when one coil lies upon the other so that the directions of their fields are the same. This contrasts sharply with the high note emitted when the fields oppose.

An iron plate laid on the coil in the secondary increases the inertia of the system and consequently lowers the pitch of the tone. In this way it may be shown that a soft iron plate changes the arc-tone more than a steel plate of equal thickness does. A plate of non-magnetic metal raises the pitch. Such a plate may be regarded as a series of closed

[3] Austin, *loc. cit.*

conductors. Interesting results may be brought out by comparing the effects of using solid metal plates and similar plates cut into sectors, insulated from one another. These results suggest the use of different forms of cores in a solenoid placed in series with the secondary circuit, or with the lamp and coil used to show induced currents.

The screening effects of conducting plates may be shown by placing them between the secondary coil and another coil in circuit with a lamp. For high frequencies, thin sheets of copper or of iron may cut down the brilliancy of the bulb very decidedly.

If a short-circuited coil is used instead of the plate, a similar screening effect may be shown.[4]

To show "resonance," arrange a second oscillating system containing capacity, self-induction, and a small lamp. If the coil of one system is laid upon that of the other, and the natural periods of the two systems are made approximately the same, the bulb lights up and the pitch of the note is changed. There is a considerable range of response in the second system, but with proper adjustment a maximum of light for varying frequencies may easily be observed. The use of two coils in series in this second oscillating system is convenient. One below the secondary coil and the other sliding on top of it makes the adjustment for maximum effect easier. The reaction of this new oscillating system on the secondary and thus on the arc may be very interestingly shown by making and breaking the new oscillating circuit while changing the capacity in the secondary circuit and noting the resulting change of pitch of the arc-note. The direction of this change depends on which of the two free periods is the greater.[5]

In conclusion it should be said that the above suggestions are made merely to call further attention to a means of demonstration which in some respects is simpler than the spark-discharge, and which has certain advantages over models.

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[4] Cf. J. J. Thomson, "Recent Researches," § 427.

[5] J. J. Thomson, "Recent Researches," § 432.

THE "ROCK WALL" OF ROCKWALL, TEXAS[1]

For many years reports of a more or less definite nature have been circulated describing the wonders of the ancient wall surrounding the town of Rockwall, Texas. The writer was able during the past winter to spend a few days investigating this supposed historic structure. It proves to be not a wall, but a number of disconnected sandstone dikes, strictly speaking, not surrounding the town, but trending in many directions. As exposures are few, they have been discovered in such scattered localities in the town's environs as to suggest the idea that they were fragments of a ruined wall.

Rockwall is located in a rich farming district about twenty-five miles east of Dallas. Black waxy soil covers the rolling hills, and only where erosion has been considerable can the underlying rocks be seen. These, when exposed, reveal blue limey strata of upper Cretaceous age in nearly horizontal attitude. A white clay, the decomposed product of the lime muds, generally occurs beneath the black soil. These lime muds are remarkable in their fredom from grit and in the peculiar property which causes them to decrepitate when exposed to the weather; notable also in that, on drying, cracks develop of various sizes. Within this series of semi-consolidated beds a few sandy layers occur. One is revealed by a drill record 1,800 ± feet below the surface; another may be seen near the town of Rockwall at the surface and consists of thinly bedded flaggy sandy limestone.

Though good exposures are infrequent, owing to the depth of soil, a peculiar condition affords ample opportunity to observe the dikes in place. These latter are natural courses for underground waters, and wells are often located on them. Though these walls are filled with water, the rock forming the dike, removed during the sinking of the well, may be examined at leisure.

The dikes are of various sizes, varying from an inch in thickness to eighteen inches or two feet. They stand vertically, or nearly so, and have in cases been followed downward fifty feet or more, always imbedded in the lime muds. They are composed of exceedingly fine-

[1] Published with the permission of the Director, U. S. Geological Survey.

grained quartz sands, cemented by calcium carbonate. So far as observed they do not vary appreciably in width through vertical range. Two joint systems, one nearly horizontal, the other vertical, have cut these dikes in such a manner as to suggest masonry walls, *i. e.*, they are composed of oblong blocks in horizontal layers.

Certain facts may be noted, however, which preclude this view. In a photograph at hand exposing a portion of the dike near Rockwall, it may be seen that many of the vertical joints occur above each other, *i. e.*, they are not broken, which condition would not exist in a wall constructed by hand. It may also be noted that the curve to the upper surface of one block exactly fits the curve on the under surface of the next block above, which leads to the same conclusion. The weathered sands between the joints, stained with iron oxide, have been mistaken for mortar.

To define accurately the steps which have taken place in the forming of these dikes is not as easy as to recognize the nature of the phenomenon. They may have originated in several ways. The sands may have come from above or from below. The cracks may be due to drying or to earth movements. The writer was not able to decide the direction from which the sands entered. Inasmuch as circulating waters have passed for long periods through the sands, dissolving and redissolving the cement between the grains, the original position of the latter can not be postulated. At present they show no signs of bedding. On breaking blocks, what might be called a stalagtitic fracture is obtained, *i. e.*, cylindrical or tubular forms arranged in vertical position. As has been pointed out, this may well be secondary structure induced by circulating water.

The limey muds were probably deposited in very clear quiet waters. A slight elevation of the sea or an increased supply of material from the land may have altered deposition and spread fine sands upon the muds. Cracks formed by earthquakes may have permitted unconsolidated sand to enter as a filling. Again, the muds may have undergone a drying-out process since their elevation above the sea, cracks may have formed from this cause, and overlying sandy layers aided by percolating waters served to supply material wherewith to fill them.

The joints may be ascribed to forces arising from slight warping of the earth's surface, acting on hard vertical masses imbedded in relatively plastic strata.

It is fair to say in conclusion that the believers in the theory which ascribes the origin of these dikes to prehistoric men are in the minority in the locality itself.

SIDNEY PAIGE

APOGAMY IN ŒNOTHERA

THERE seemed at one time a possibility that the phenomena of mutation in *Œnothera Lamarckiana* might be associated with a condition of apogamy in that species. A survey of the hereditary behavior, however, and particularly of the results of certain crosses between the mutants and *O. Lamarckiana*, and also among the different mutants themselves, soon made it apparent that such a condition could not be of high frequency at any rate, in the parent form or in such mutants as *O. rubrinervis* and *O. nanella*. The results of crosses between *O. Lamarckiana* or certain of its mutants, and such wild species as *O. biennis*, also could only be explained by assuming that fertilization had taken place uniformly in the ordinary way, and often the resulting hybrids show the predominating influence of the pollen parent.

But while it seems highly improbable that apogamy in *O. Lamarckiana* is concerned in the origin of the mutants, yet, as I shall proceed to show, there is some very good evidence that one at least of these mutants is itself apogamous, though only in a small percentage of cases.

Œnothera lata is well known to be sterile in its anthers, so that self-fertilization has never been effected. MacDougal[1] has reported that the form closely resembling *O. lata*, from near Liverpool, England, can be self-fertilized, and

[1] "Mutations, Variations and Relationships of the Œnotheras," Carnegie Inst., Pub. 81, p. 15, 1907.

I have accomplished the same result in several cases in subsequent cultures of these forms. But I find from this summer's cultures that this type differs constantly from the *O. lata* of de Vries, as the latter appears in cultures or as a mutant from *O. Lamarckiana.* In bud characters it resembles *O. semilata,* but the leaf characters are closer to those of *lata* than to *semilata.* Hence while agreeing with the *lata* mutant in most of its characters, it differs constantly from the *lata* which is a derivative of the Amsterdam cultures, in its ability to produce a considerable amount of viable pollen, as well as in the (probably correlated) shape of its buds.

The frequent association in various genera, of apogamous conditions with the failure to produce pollen, led me to consider the possibility that *O. lata* might show a similar condition. This surmise has since been strengthened by certain facts recorded by Miss Lutz.[2] She found certain *O. lata* plants having the *lata* number of chromosomes, in the first generation of hybrids from *O. lata* × *O. gigas.* I have referred to this in a recent publication[3] and suggested that the most probable explanation is that they originated apogamously. The facts are these. In a total of about forty plants from the F_1 of *O. lata* × *O. gigas* Miss Lutz found (I.) two plants which were identical with *O. lata* in every respect and had fifteen chromosomes; (II.) six plants which were very similar to *O. gigas,* having about thirty chromosomes so far as counts were made; and (III.) thirty-two plants which, though not clearly characterized in the description, seem to have been in part intermediate between *O. lata* and *O. gigas,* and in part intermediate between *O. Lamarckiana* and *O. gigas.* A portion of these latter plants are stated to have twenty-two somatic chromosomes, "others twenty-three and some possibly twenty-one chromosomes." Whether these hybrids all had the same individual *O. lata* plant as mother is not stated, but if this was the case and the mother had fifteen chromosomes, then we might expect the two *lata* plants in the offspring both to have fifteen chromosomes, and the hybrids of class III. to have twenty-one or twenty-two chromosomes (14 + 7 or 14 + 8), while in the case of the *O. gigas*-like plants which are stated to have had thirty chromosomes in the individuals in which a count was made, the expectation would perhaps be twenty-nine (15 + 14).

How the *O. gigas*-like individuals having about thirty chromosomes originated must, however, be a matter of conjecture at the present time.

Miss Lutz calls the *O. lata* plants in this cross "extracted latas," which would indicate their hybrid origin. But in view of the fact that they have the *lata* number of chromosomes (14 or 15) and in view also of the subsequent data which I am about to state, it seems highly probable that they originated apogamously from the *O. lata* parent.

De Vries[4] made the cross *O. lata* × *O. gigas* in 1905 and grew one hundred and thirty-three of the offspring in 1907 and a smaller number in 1908. Of the former number sixty-eight were found to be intermediate between *O. lata* and *O. gigas,* and sixty-five intermediate between *O. Lamarckiana* and *O. gigas,* and the 1908 culture repeated the same two types, also in about equal proportions. From this it appears that there were no pure *O. lata* individuals and hence could have been no apogamy in these cultures at Amsterdam.

The peculiarities of *O. lata* are such that there need be no difficulty in distinguishing it from *O. Lamarckiana* or *O. gigas* or even from forms intermediate between *O. lata* and *O. gigas.* The further fact that Miss Lutz found the two *lata* individuals in her cross to have fifteen chromosomes, supports the belief in their apogamous origin.

In my experiments this summer, to determine more definitely the occurrence of apogamy in *O. lata,* I removed the anthers (which

[2] "Notes on the First Generation Hybrid of *Œnothera lata* × *O. gigas,*" SCIENCE, 29: 263–267, 1909.

[3] "The Behavior of the Chromosomes in *Œnothera lata* × *O. gigas,*" *Bot. Gaz.,* 48: 179–199, pls. 12–14, 1909. This paper deals with the chromosome behavior in the germ cells of hybrids having 20 and 21 chromosomes.

[4] "Bastarde von *Œnothera gigas,*" *Ber. Deutsch. Bot. Gesells.,* 26a: 754–762, 1908.

were always dry and empty) from several flowers of an individual of *O. lata,* at the same time removing the stigma and style by pulling the latter out at the base as an extra precaution, afterwards covering the flower with a bag and marking the capsule according to the method I ordinarily use in making guarded crosses. All of the flowers so treated but one gave negative results, but this one produced three fair-sized seeds.

Ordinarily, if, for some reason, a flower fails to be pollinated, the ovules remain very small and gradually dry up and wither, so that after a few weeks such an ovary has not grown in size and if broken open shows numerous small, dried granules which are the remnants of the deteriorated ovules, many of them still attached in their original position. These three seeds, while slightly below the average in size, yet were hundreds of times larger than the small remnants of such unfertilized ovules, and indeed there were many of the latter in the capsule in question, in addition to the three seeds.

In every case where pollination was thus prevented, the ovary remained very small and gradually dried up and shrank to a small diameter, and the one containing the seeds was but little larger than the rest. Several of these small dry ovaries fell off and hence were never examined for seeds. The number of seeds, if there were any present, could not have been large in any of them.

I also treated, in a similar manner, a number of flowers from several individuals of the English *O. lata,* which produces some pollen; but without exception the results were negative.

In this connection will be recalled the discovery of Ostenfeld[5] and Rosenberg[6] that certain species of *Hieracium* are partly apogamous or aposporous, and partly require fertilization. But in this genus of Composites, where each flower of a head develops a single seed which is independent of all the other seeds of a head, the conditions of nutrition are much more favorable to partial apogamy when pollen is excluded from the head, than is the case in an *Œnothera* capsule where the ovules are closely crowded together into four chambers and the deterioration of the great majority of them in the absence of fertilization is likely to carry down the others in the common ruin and also to lead to the cutting off of the common food supply.

So far as I am aware, the only other indication of the development of embryos in *Œnothera* without previous fertilization is in *O. gigas.* Schouten[7] reports obtaining one *O. lævifolia* individual in a large culture of *O. gigas.* Now I have found that *O. lævifolia* has fourteen chromosomes, while *O. gigas* is known to have twenty-eight.[8] Such an individual of *O. lævifolia* might have arisen from *O. gigas* through a process of parthenogenesis in the restricted sense of Strasburger,[9] an egg with the reduced number of chromosomes producing the embryo without fertilization. At present no case of this sort is known in the plant kingdom, although in echinoderms and various other animals the artificial production of larvæ from unfertilized eggs is a well-known fact and, in some of these cases at least, the number of chromosomes is the reduced number. Whether the origin of this *O. lævifolia* individual was of a similar sort must remain for the present undecided. The fact that in such plant genera as *Alchemilla* and *Hieracium* the apogamous members of the genus frequently have about twice as many chromosomes as the normally fertilized members would make the occurrence of similar conditions in *O. gigas* a thing which might reasonably be anticipated.

This indication of apogamy in *O. lata* of

[5] "Castration and Hybridization Experiments with some Species of *Hieracia,*" *Bot. Tidsskrift,* 27: 225–248, 1906.

[6] "Cytological Studies on the Apogamy in *Hieracium,*" *Bot. Tidsskrift,* 28: 143–170, 1907.

[7] "Mutabiliteit en variabiliteit," p. 93, dissertation, Groningen, 1908.

[8] In all these forms there are probably occasional departures of one or more chromosomes from the usual number, owing to the occasional irregularities in chromosome distribution which I have shown (*Bot. Gaz.,* 46: 1–34) to occur in the formation of the germ cells.

[9] "Apogamie bei Marsilia," *Flora,* 97: 163, 1907.

course requires to be substantiated by a more detailed study and I am making a cytological investigation of the embryo sac development and fertilization in *O. lata* with the hope of obtaining more conclusive evidence of the presence of some form of apogamy in this mutant.

R. R. GATES

MISSOURI BOTANICAL GARDEN,
September 29, 1909

MEMBRANE FORMATION AND PIGMENT MIGRATION IN SEA URCHIN EGGS AS BEARING ON THE PROBLEM OF ARTIFICIAL PARTHENOGENESIS

IN a recent number of SCIENCE McClendon[1] has summarized his work on artificial parthenogenesis in *Arbacia* and discussed it with reference to changes in permeability of the surface layer of the egg. With the same point in view, during June and July at Tortugas and the latter part of August, 1909, at Woods Hole, I have been studying the earliest changes taking place in developing sea urchin eggs, especially the formation of the fertilization membrane.

Ever since the paper of Delage appeared, on electric parthenogenesis, I have been impressed with the great similarity in the means of stimulating eggs to develop and the means of stimulating muscles and sensitive plants. Morgan expressed the situation clearly when he compared the means of causing development to a stimulus. A considerable mass of evidence now exists, especially emphasized in recent papers of Ralph Lillie, that stimulation of muscles is effected by a momentary increase in permeability of the muscle membrane to CO_2, allowing its more ready escape during contraction. CO_2 is the chief end product of the energy-yielding reaction on which contraction depends and its removal from the cells allows the reaction to proceed (during contraction) to a new equilibrium (of rest), when checked by a second accumulation of CO_2. The increase of permeability on stimulation removes the condition which is preventing the contraction. The movements of sensitive plants can best be explained as due to an increase in permeability of the cell membranes relative to the turgor-maintaining substances. The important point is that processes in general brought about by stimulation are connected with changes in permeability. This holds good for secretion, and the fact that the first visible change in many eggs is a secretion is certainly significant.

Several authors have recorded instances of development without membranes, perhaps the best known case being parthenogenesis by hypertonic sea water. I have repeated this experiment and find that there is without doubt a surface change in the egg, visible on slightly high focus, which I take to be a membrane very close to the egg surface. Similar membranes are produced in *Hippanoë* eggs by treatment with CH_3COOH. They are hardly noticeable even with the high power. Very close fitting membranes and membranes which surround each blastomere when the egg divides may be produced in other ways. It seems as if development without membranes was rather a case of development without pushing out of the membrane.

This pushing out appears to be due to the formation of some substance exerting an osmotic pressure between it and the cell surface, which absorbs the surrounding sea-water. It would be impossible for the fluid between fertilization membrane and egg to have come from the egg without a greater diminution in volume than is observed in eggs immediately after fertilization. Loeb[2] has discussed the above view and designated a proteid or lipoid as the substance in question. A very small concentration of some substance formed just behind the fertilization membrane would account for its pushing out, provided the membrane were impermeable to the substance and freely permeable to the salts of sea-water. For the latter there is ample evidence.

The membrane itself is a secretion comparable to the cellulose layers formed on plant cells after division. It is composed of some substance of a highly resistant nature

[1] N. S., XXX., p. 454, October 1, 1909.

[2] *Arch. Entw. Mech.*, XXVI., 1908, p. 82.

as is shown both by its insolubility in concentrated mineral acids, including sulphuric, and also on short boiling in molecular solutions of caustic alkalis. On prolonged boiling it either dissolves or becomes so broken up as to be unrecognizable. The egg itself dissolves entirely in concentrated H_2SO_4 and in NaOH except for a few granules. Unfertilized eggs dissolve entirely in concentrated H_2SO_4, showing that the membrane is not present before fertilization. It is also left undigested by pepsin HCl.

Regarding the membrane as a secretion, its formation is strong evidence that an increase of permeability, of which it is the direct result, is brought about by the various membrane-forming substances. Its removal from the sphere of reacting substances (in the egg) must upset any chemical equilibrium which has been attained, this equilibrium meaning a condition of rest and non-development of the egg.

The second visible change occurring in some sea-urchin eggs, *e. g., Arbacia,* is the migration of the red pigment granules, which, until after formation of the fertilization membrane are distributed throughout the cytoplasm, to the periphery of the egg, as mentioned by McClendon. This migration can be explained on the assumption that the change of permeability associated with membrane formation is connected with ionic interchange between exterior and interior of the cell giving rise to potential differences such as are seen in the functioning of glands, muscles, nerves and sensitive plants. Lillie[8] has discussed this, theoretically, in a paper in which an increase in permeability is also taken to be the change bringing about development. "With the appearance of an increased permeability . . ., the peripheral regions of the protoplasm must become, for a time at least, until the potentials are equalized, *positive* relative to the interior." Most small particles suspended in a fluid become negatively charged and migrate in an electric field. The fact that these bodies are repelled by the asters is further evidence for regarding them as negative, for Lillie has suggested several reasons which point to the asters as regions of negative charge. It is on account of the prominent asters present at this stage that the micromeres are free of pigment. Even when cut off from the pigmented area of centrifuged eggs these cells are relatively free from pigment granules.

Such small electro-negative particles, in equilibrium under conditions of rest in the cell, would, on an increase of permeability, migrate toward the now positive cell surface. A calculation (by Lillie) of the potential difference which might arise, based on the observed changes in muscle cells, gives a value of 14 volts per cm., which would be ample to account for the changes observed in *Arbacia.* This same movement occurs in eggs treated with hypertonic sea-water and CH_3COOH.

This change in potential must be accompanied by an increase in surface tension (see Lillie) and it is quite generally true that the surface tension increases immediately after fertilization, as indicated by the rounding up of eggs which were previously oval or elongated in shape.

The facts which indicate an increase in permeability of the surface membrane as the first change taking place in the development of an egg may be summarized as follows:

1. The general similarity in the means of stimulating eggs to divide and the means of stimulating muscles and sensitive plants. These may be broadly classified as chemical, mechanical, electrical, thermal and osmotic.

2. The fact that the chemical substances which start parthenogenesis cause in other cells an increase in permeability (hæmolysis of red blood corpuscles and loss of pigment in pigment-bearing cells).

3. Evidence that stronger concentrations of development-starting substances cause loss of pigment in pigmented eggs.

4. That a secretion is the first visible change occurring in many eggs.

5. That a migration of pigment-containing granules to the cell surface in *Arbacia* eggs is caused by a region of positive charge at the surface resulting from ionic interchange ac-

[8] *Biol. Bull.*, XVII., p. 207, 1909.

companying increased permeability after membrane formation.

6. That an increase of surface tension, which must accompany a change of potential at the surface, is quite general in naked eggs after fertilization, as indicated by their rounding up when previously they had been irregular in outline.

A logical explanation is afforded why such a change as increased permeability should cause development, namely—the removal of some reaction product whose accumulation has brought the cycle of reactions occurring during the growth period to a standstill. This does not exclude the possibility that in time another change may take place which leads to those disintegrative changes, especially emphasized by Loeb.

E. Newton Harvey

Columbia University,
October 7, 1909

SOCIETIES AND ACADEMIES

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

The 668th meeting was held on October 9, 1909, Acting President Wead presiding. The following papers were read:

Reversion of Power Series: C. E. Van Orstrand, of the Carnegie Institution of Washington.

The equation which Professors Harkness and Morley developed for the reversion of a power series was extended so as to obtain a general term for the reverse series similar to the one obtained by Professor McMahon. The complete expansion for the first thirteen coefficients was given, and some comment was made in regard to the application of the reverse series to inverse functions including solutions of polynomials of the *n*-th degree.

The Vibration Galvanometer: Frank Wenner, of the Bureau of Standards.

The vibration galvanometer is an instrument for the detection or comparison of small alternating currents and electromotive forces. It differs from other instruments for the same purpose mainly in having the moving system tuned to the frequency of the current or electromotive force to be investigated.

The general theory of the instrument was developed, and equations derived which show how the amplitude of the vibration depends upon the various constants of the instrument and the conditions under which it is used. An auxiliary set of equations gives all the constants in terms of quantities easily measured. This makes it possible, with but few simple measurements on any particular instrument, to predict its behavior under almost any set of conditions, or to calculate the effect of any contemplated change in the design.

It has been observed that some instruments resonate to two different frequencies. The cause of this double period of the moving system was explained. For those instruments which develop a relatively large back electromotive force the effect of putting a large inductance in the circuit is shown and the advantage of using a step-up transformer is pointed out.

The experimental part of the work has to do mainly with the verification of the more important relations shown by the equations. The constants of the different instruments used were obtained, using the theory developed. Some of the constants are also determined by an independent method and thus serve as checks on the theory. A method of tuning was given which is more sensitive than the method generally used and which is applicable in other cases where the vibration is forced.

W. P. White, of the Carnegie Institution of Washington, spoke informally on the zero shift in moving-coil galvanometers, discussing briefly its cause and how it may be lessened.

R. L. Faris,
Secretary

THE CHEMICAL SOCIETY OF WASHINGTON

The 192d meeting of the Washington Section of the American Chemical Society was held at the George Washington University Lecture Hall on October 14, 1909. President Walker presided, the attendance being 94. Dr. H. W. Wiley gave a report of the seventh International Congress of Applied Chemistry, held in London in May and June of this year, including a history of the development of the society. He described the entertainments furnished by the British members, told of the more important papers presented at the meeting and of the personnel in attendance, and the part taken by some of the prominent American chemists. Twenty-one new names were added to the list of members and twelve names removed.

J. A. LeClerc,
Secretary

SCIENCE

FRIDAY, NOVEMBER 19, 1909

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE INFLUENCE OF CHEMISTRY ON CIVILIZATION[1]

THE future of a country depends on the education of its youth, and the education of its youth must be in competent hands. Whoever first spoke these truisms knew his subject, for we have only to look at those countries where education is not enforced, or even easily attained, to find a country so backward that its relations with the rest of the world are stunted. In many of the countries of Europe illiteracy is universal. In Hungary, for example, we still find that the signs in front of a shop are painted pictures of the wares offered for sale, because many intending purchasers can not read, but they know that the graphic portrayal of a hammer and a saw indicates that tools are sold within. What have those countries like Roumania, Bulgaria, Bohemia, Hungary, Russia, and dozens of others, ever amounted to, and what are their commercial relations with the rest of the world, compared with Germany, France, England or the United States?

The law in the United States and England recognizes only three professions—law, medicine and theology—and long before law and medicine became professions, theology was the only profession, because only the priests and the scribes could read and write. The theologians of ancient times were the early teachers, and one of the first institutions of learning which was carried on systematically (excepting the teachings of Gotama and Confucius) was the Sanhedrin where the Mosaic and

[1] Address by the chairman of the Society of Chemical Industry.

Deuteronomic codes were taught, and the twenty volumes of the Talmud are to-day the classics of that college of learning.

It so happened that preachers became teachers, and down to our present time we have many colleges, all over the world, where preachers are in charge and dictate the policy of the institutions.

I must not be misunderstood in any criticism which I am about to make, for I have no quarrel with any religious profession, but if we examine into the mental status, and analyze the mind of the theologian, we find that he is accustomed, once or twice a week, to preach from the pulpit, relieving his mind of opinions on questions and subjects which have been thrashed out time and again, and from the very nature of his audience, and the sanctity of the edifice from which he speaks, no one contradicts, no one argues, no one says him nay, until by that mental process with which we are familiar, he believes himself unanswerable, and takes even his glittering platitudes as facts undeniable.

Such a man placed at the head of a university where science is taught is evidently not as good as a man who has been trained to judge cause and result, and whose scientific work has been criticized by his equals, and as a comparison we have at least three large and well-known colleges that I know of—and, for all I know, there may be many more—at whose head there are, or were, chemists and scientists of distinction, and every one of these has turned out men who have given a good account of themselves. Nor do I want to except those excellent universities which are guided by literarians and other intellectually developed men other than theologians, for the success of those colleges is equal, comparatively, to those presided over by chemists. A school of medicine is best presided over by a doctor, a school of engineering by a man who is educated in one of its branches, a military school by a soldier, and a school of theology by a minister of the gospel. Our greatest success in schools of chemistry will therefore come from the very chemists who direct their policy.

Chemistry needs no sponsor, but its effect on civilization has been more marked than that of any other science. True, it has reached out and taken electricity and physics as its aides, but withal, engineering made but little progress until steel and cement, two chemical products, were cheapened, simplified and made universal. Medicine has claimed great honors, but the masterful work done in coal tar chemistry, in the production and discovery of synthetic drugs, the discovery of anesthetics, the marvelous work done in the metabolism of matter, the excellent analytical schemes for the waste matter of the tissues, are all due to the researches of chemistry, and their civilizing influence is greatly felt.

Many a chapter has been written on the regeneration of Germany. Where once barren fields stood, so barren that foodstuffs would not grow, there have arisen vast works bristling with the stacks of factories, and thousands of commercial flowers grow where once not even a weed would flourish. And in all these plants chemists are working, controlling the products that are made, and creating new things, and for every new and useful compound more work is found, and whereas, emigration was the rule in Germany thirty to fifty years ago, and its best people left it like rats from a sinking ship, to-day many are immigrating, for it's a flourishing land which chemistry has retrieved. Germany was always poor up to ten or fifteen years ago. With one or two possible exceptions, no vast industries existed, and it had nothing to export, but to-day its exports are enormous, its people prosperous, in sad comparison to its neighbor, Austria, where

industry is making slow progress compared with Germany.

The United States is practically an agricultural country, for its wheat, cotton, flaxseed, corn, cereals and lumber are larger than its manufactures, yet it soon will lead in metals, and it is fast coming to the front in its chemical industries.

The engineer may brag of his skill, but he has done nothing greater than the pyramids, nor finer than the temples of Greece and Egypt. The monuments he has wrought in steel were given to him by the ability of the chemist to control carbon in iron, and the economic principle involved in the production of steel supplies work, puts money into circulation, and keeps the wheels turning.

If it were not for chemistry and the knowledge that has been gained in the fertilization of soils, we would have often exhausted the miles of ground which have made this country what it is, and even now the very work which is going to maintain the entire civilization is the production of nitrogen from the air, a purely chemical investigation which may be the greatest civilizing factor of the age.

Twenty-five years ago the chemist was a man who made analyses, and whose knowledge was confined to inorganic materials, and a few organic substances. To-day there are very few analytical chemists in ratio to the population, for nearly all works maintain laboratories where chemists are employed and researches are continued, so that by-products which formerly were waste, to-day are converted into commercial products.

The brewing industry years ago looked upon the chemist with considerable doubt, for the first influence the chemist had upon the brewing industry resulted in the manufacture and use of bicarbonate of soda to produce froth, and salicylic acid to prevent fermentation. It took the chemist many years to convince the brewer that he could do without these materials, and to-day the modern brewmaster has a chemical training and conducts the process of brewing upon scientific principles.

It is only a few years ago that some of our members assembled at the grave of Priestley and marked the centennial of the discoverer of oxygen.

For a science so young, its civilizing influence is enormous, and there is no doubt that the rapid progress which it made in the nineteenth century will be outstripped in the twentieth, for the control of our foodstuffs, the application of the raw materials in the earth, and the refining of metals, create positions, give progress to a country, and help largely in the establishment of that profession in which we are all factors.

Maximilian Toch

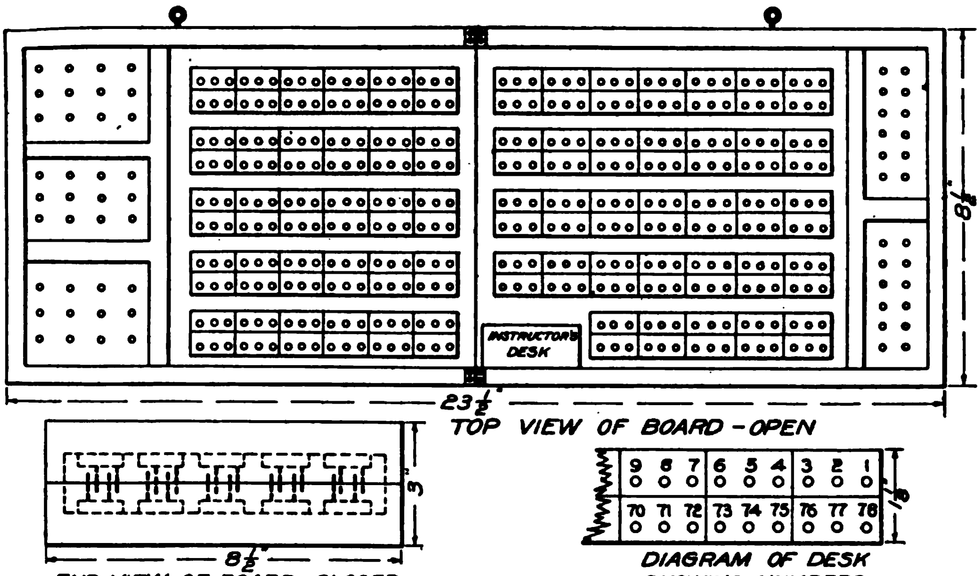
New York City

A PROBLEM IN LABORATORY ADMINISTRATION—ITS SOLUTION

A reading of the excellent article by Professor Baskerville on "Laboratory Organization" which appeared recently in Science, has prompted the writer to speak of one of the difficult phases of laboratory administration and an attempt at a suitable and efficient solution of the same. This note is written in the hope that it may offer some suggestion to those working on the same general question, modified, of necessity, by local conditions.

For a number of years there has been a steadily increasing growth in the number of students taking general elementary chemistry in this laboratory, until the gross registration for the present academic year shows an enrolment of 725. For lecture purposes this number is divided into four sections of 220, 220, 180 and 105 each; for quiz into groups of 25 to 30 each. For laboratory purposes, the classes are divided into eight sections, which are accommodated in two large laboratories, each containing 126 desks of three lockers each, or a total of 756 lockers. The general

plan for laboratory work is to assign three students, each of a different section, to every desk, one locker being provided for every person. The laboratory sections vary in size from 80 to 110 students, and it thus becomes apparent at once that assignment of lockers on the above basis becomes increasingly difficult as the total number of students approaches the total number of lockers. This phase of laboratory administration together with that arising from the registration of students during the academic year; unavoidable transfers in sections due to change of daily schedule; students withdrawing from the



TOP VIEW OF BOARD - OPEN

END VIEW OF BOARD - CLOSED

DIAGRAM OF DESK SHOWING NUMBERS

university; rearrangement of students in order to economize the time of the teaching force; these with others that readily suggest themselves have been questions demanding quick and efficient solution. In order to meet these situations successfully and with the greatest economy in time, the following device has been prepared. Two key-boards have been constructed, each being a model of the general desk arrangement of the laboratories (see design for details). In the numbered holes are placed steel dowel pins, painted in various colors. To illustrate better the general assignment above mentioned and the use of the board for these purposes, an actual case is given; the Monday and Tuesday afternoon laboratory division (lockers 1, 4, 7, 10, 13, etc.) are all indicated by yellow pegs; Thursday and Friday afternoon division (lockers 2, 5, 8, 11, 14, etc.) by red pegs; Wednesday and Saturday division (lockers 3, 6, 9, 12, etc.) by white pegs, other sections by other colors. After all the students have been assigned lockers, a record of the same is made on numerically tabbed index cards and thus a complete record of both laboratories is kept in the office of this division of the department of chemistry. A glance at the details of the diagram shows that each board can be folded without the least danger of the pins becoming displaced. By means of an alphabetical card index (5" × 4"), used in conjunction with the above, there is kept always at hand such data in reference to the student as name, college, locker number, number of course, test grades, laboratory grades, quiz grades, final grades, term standing, laboratory section, quiz section, lecture section, etc. One further example of this system will illustrate its use; notice is received by the department of chemistry from the registrar that John Smith has withdrawn from the university. On receipt of the same, the alphabetical index is consulted for locker number of the student, say number 12. The with-

drawal and date are noted on this card, which is then refiled. Card 12 of the numerical index is withdrawn and replaced by a new one, at the same time peg 12 is taken from the board and placed in the side compartments, the vacant peg-hole showing at a glance the availability of this locker. In assignment of available lockers, one need only bear in mind that two pegs of the same color can not be placed on the same desk, and thereby conflict will be avoided. Thus, without multiplying examples, it at once becomes apparent that this system gives one a ready and simple control of the laboratories. By this system, classes of seven hundred are handled with great facility.

The writer wishes to express his thanks to Mr. Harry Mougey, of this laboratory, for several suggestions made in the construction of the above board. WM. LLOYD EVANS

OHIO STATE UNIVERSITY,
September 8, 1909

EDUCATIONAL AIMS IN THE TEACHING OF ELEMENTARY GEOMETRY, HISTORICALLY CONSIDERED[1]

THE two educational aims that have stood out distinctly in the history of the teaching of geometry are the practical[2] and the logical. Of course in the early development of geometry the term teaching can not be used with its modern significance. The practical side of geometry was developed by the Babylonians, the Egyptians and the Romans; the logical by the Greeks. In the medieval universities the little geometry taught was according to Euclid. England has followed the same standard to the present day. The other European countries, for the most part, have combined both of these aims, and this obtains to-day, with the emphasis on the logical. The same is true in the United States. A third aim in the teaching of geometry arose when the secondary schools began to assume the character of preparatory schools for the universities. The last hundred years have seen this generally brought about, and within the last fifty years it has been fully systematized in the various countries. In treating these several aims it is impossible to completely separate them.

The early Egyptians and Babylonians developed geometry as a means toward a practical end. Both nations were interested in astronomy, and hence a rudimentary geometry found a place with them. The Egyptians employed geometric principles in the building of their pyramids and in surveying. They measured lengths and areas, they built solids of regular design, they showed some skill in geometric drawing in their mural decorations. With all this they experienced the necessary propædeutics for a developed science, yet this development never came. Whether it was the lack of God-given powers or due to the conservatism of the priestly class, that sacredly guarded the learning, one can only conjecture.

The Romans, also, valued geometry for its utility, employing it in architecture and in surveying. But, unlike the Egyptians, they had the learning of other nations to draw upon. This development in architecture and surveying was marked in the first century before and the first century after Christ. Euclid had written his "Elements" approximately three hundred years earlier. Archimedes had already developed geometry as applied to mechanics, and Heron of Alexandria, who studied and wrote on practical geometry and surveying, lived in the early years of this "Roman" period. The work of Heron influenced the Roman surveyors, but Euclid found little favor with the Romans. When the "Elements" was recognized at all, it was that it might be of aid in the training of the orator, which was, for the Romans, a practical aim. In like manner the Hindus and Arabians studied geometry primarily for its practical value, although both of these nations were largely dependent upon the Greeks for their knowledge of geometry.

[1] See the author's "A History of the Teaching of Elementary Geometry," Teachers College Contributions to Education, No. 23, for the original and secondary sources consulted. The present article is not an integral part of the larger work, but material from the latter is utilized in the former.

[2] The term practical is used with reference to the applications of geometry within the field of mathematics or in the related fields of science.

The nations that have been considered thus far emphasized only the practical side of geometry, and we find with them no plan of education that provided for its systematic instruction. The early Christian schools taught geometry in a small way, but the practical was almost entirely neglected. The medieval universities made provision for the applications of geometry, but such work was independent of Euclid.

The Greeks were the first nation that developed and consistently taught a logical system of geometry. Although they were interested in astronomy and the physical sciences (which undoubtedly stimulated their study of geometry), yet the practical was completely divorced from the logical, as is shown in the text of Euclid. The chief function of education, according to the old Greek idea, was the perfection of the human being, body and soul. Hence gymnastics and music constituted almost entirely the program of studies for the growing boy. When the new education with its philosophy and mathematics entered into the Greek life, it served as the completion of an edifice whose foundations had already been laid. Hence the logic of geometry thrived in Greece. But in the development of this science, the Greeks were stimulated by a sort of practical aim in attempting to solve the three famous problems of antiquity: the quadrature of the circle, the duplication of the cube, and the trisection of any angle. In the actual teaching of the subject, however, the Greeks were more interested in the chain of reasoning than in the subject-matter itself.

Logical geometry next found a place in the medieval universities. Under the influence of monasticism and mysticism the church schools were more interested in religious than in intellectual things. Then scholasticism arose and dominated European education from the eleventh to the fifteenth century. It sought "to bring reason to the support of faith," and logical inquiry was stimulated. The universities began their careers under such influences, and when Euclid became known to medieval Europe, it found a place in the curricula of these institutions, where it was taught in the highest class. Undoubtedly it was looked upon as the instrument that completed and knit together the logical faculties of the mind. The universities did not neglect science. In particular the "sphæra" was studied, but it bore no relation to the logical study of geometry. A thing for us to remember is that these institutions followed the example set by the Greeks. Geometry and the physical sciences were both studied, but the former was developed without any reference to the latter.

In the teaching of geometry, the different European countries have held to the strictly logical in varying degree. Italy has Euclidean traditions, but England above all has taught geometry primarily on the logical basis. Euclid has there reigned supreme. Until recent years English higher education has meant the education that fits for the so-called higher callings. The public schools, which prepare largely for the universities, have had this same conception. Any training that smacked of "trade" was not considered to be a part of the education of an English gentleman. The result has been that the classical side has been particularly emphasized and practical education has been almost neglected. In recent years the modern university movement in England has furthered technical and industrial education, and we now find secondary and higher technical schools that are beginning to fill this gap in the English school system.

Thus far we have mentioned the marked tendencies among certain nations and institutions to hold either to the practical or the logical in the teaching of geometry. With reference to other nations, Germany and France, for instance, have never held to the rigors of Euclid, and Russia has begun only in comparatively recent years to emphasize the scientific teaching of geometry. Let us look into the aims in some of those countries where the extremes of aim have not been so disassociated.

The Renaissance of the fifteenth and sixteenth centuries brought no change in the teaching of mathematics in the universities. This result could hardly be expected from a movement entirely classical in its nature. It was not until the latter part of the seventeenth century, under the influence of realism, that

the universities began to change the character of their work, and modern science was included in the curricula. The geometry taught in the secondary schools of Germany up to the seventeenth century was taught largely in connection with astronomy and surveying, copied after the work done in some of the medieval schools. The logical aim became more prominent by the beginning of the eighteenth century when science began to assume its more modern form.

In Russia, geometry was first taught from the practical standpoint. The logical aim was long in getting recognition. It was not until the end of the eighteenth century that geometry received any great attention as a science. In France, the early texts show that the practical in geometry was valued as well as the logical. In Holland, the beginning was practical, the eighteenth century marking a more logical trend, when the teaching was made systematic. In the United States, the first geometry taught was of a practical nature, but the English influence was soon felt, and it was not until the first quarter of the nineteenth century that the more practical geometry of the French began to replace the English Euclids.

Another aim has characterized the teaching of geometry, an aim different from the two already considered, but still not standing apart from them. It is associated with the study of geometry as a preparation for advanced work in mathematics. This aim is a recent one in the teaching of geometry. Before the latter part of the eighteenth century, in no strict sense could the secondary schools that have here been considered be called preparatory schools for the higher institutions.

It was not until 1788 that the Prussian government required an examination from all who entered the universities, and it seems that this was not at first rigidly enforced. One may safely judge that previous to 1788 the aim of preparing for advanced study was not a dominant one in the gymnasia. On the creation of the lycées in France by Napoleon in 1802, these schools began to assume the character of preparatory schools for the university and the various government schools. In England, the secondary schools did not begin to teach Euclid until the early part of the last century, and it was not required in general until about the middle of that century. It has been only within fifty years that these schools have in any strict sense prepared for the universities. In Russia, students at first passed from the seminaries and the ecclesiastical academies into the universities, but in 1759 the gymnasia began to act as preparatory schools. The secondary schools of Holland began to prepare for the university in 1815, but as far as geometry was concerned, the requirements were not strictly defined. In the United States the universities did not require geometry for entrance before 1844. Since that date the high schools have assumed more and more the function of preparing students for advanced work in the universities.

One of the results of this close relation between the university and the secondary school has been an improvement in the teaching of geometry from the scientific standpoint, but, in the United States at least, while the teaching of geometry has been better developed logically, its practical side has been correspondingly neglected in the high schools.

Alva Walker Stamper

Chico, Cal.

A NEW NAME FOR A NEW SCIENCE[1]

The following list, though noticeably brief, attempts to include all books and memoirs in which the facts of history of a personal nature have been subjected to statistical analysis by some more or less objective method. Such researches may be made to contribute to the science of eugenics. They also stand upon the border line of the allied sciences, psychology, anthropology and sociology. Since investigations of this nature contribute to several sciences, and at the same time primarily

[1] "Some Desiderata in the Science of Eugenics and Bibliography of Historiometry," by Dr. Frederick Adams Woods. Reprinted from Vol. V. of the American Breeders' Association Report of the Meeting, held at Columbia, Mo., January 6, 7 and 8, 1909. Report of the Committee on Eugenics. Bibliography of Historiometry (Quantitative History) now printed for the first time.

to the philosophy of history itself, it seems necessary to have some special name to designate this class of work. The word "biometry," already in general use, does not meet the requirements. It fails to express the primary value of this class of research, namely, elucidation of the philosophy of history for its own sake, and also fails to suggest that the work should be carried forward by the historians themselves. I propose the word "historiometry," derived from the Greek ἱστορία, history, and μέτρον, measure. Historiometry bears the same relation to history that biometry does to biology. It may be noticed that these investigations treat only of groups of individuals. I am already convinced from the indications of several researches which I have now under way, that the quantitative method may be successfully applied to historical events of a more general character.

BIBLIOGRAPHY OF HISTORIOMETRY

de Candolle (Alphonse). "Histoire des sciences et des savants depuis deux siècles." Genève, etc. (H. Georg), 1873. Contains lists of scientific names objectively (impersonally) compiled.

Cattell (J. McKeen). "A Statistical Study of Eminent Men." *Popular Science Monthly*, February, 1903, pp. 359–377. [Abstract in *Psychological Review*, March, 1895.] The names of a thousand eminent men of all time are here arranged in the order of their eminence by the strictly objective, and valuable "space method." Attempt should be made to test the limits of the accuracy of this method by comparing these names with those selected by other methods.

Cattell (J. McKeen). "A Statistical Study of American Men of Science." *Science*, November 23, November 30, December 7, 1906. Although the facts are not drawn from history, they are useful as a check to compare with historical statistics. The names were selected by the "method of voting."

Ellis (Havelock). "A Study of British Genius." London (Hurst & Blackett), 1904. [First appeared in *Popular Science Monthly*, February–September, 1901.] A valuable study based upon the "Dictionary of National Biography." Contains lists of British men of genius and talent, objectively derived and useful for further study.

Galton (Francis). "Hereditary Genius. An Inquiry into Its Laws and Consequences." 2d edition. London (Macmillan), 1892. The earliest of biographical statistical studies, first published in 1869. Many of the lists of names are not compiled by any strictly objective method.

Galton (Francis). "English Men of Science, Their Nature and Nurture." London (Macmillan), 1874. Fellows of the Royal Society.

Galton (Francis) and Schuster (E.). "Noteworthy Families." London (Murry), 1906. Families of scientific men objectively studied.

Jacoby (Paul). "Études sur la sélection chez l'homme." Avant propos par Gabriel Tarde. 2d edition. Paris (Alcan), 1904. The last quarter of this work dealing with the origin of French men of talent has decided scientific value. The first portion of the book deals with royalty, *le pouvoir*, contains no statistical treatment, and is entirely misleading.

Lorenz (Ottokar). "Lehrbuch der gesammten wissenschaftlichen Genealogie." Stammbaum und Ahnentafel in ihrer geschichtlichen, sociologischen und naturwissenschaftlichen Bedeutung. Berlin (Hertz), 1898. Suggestive at the time it was written, but contains scarcely any statistical treatment.

Odin (A.). "Genèse des grands hommes gens de lettres français modernes." 2 vols. Paris (H. Welter), 1895. A study of 6,382 French men of letters. Valuable for its facts. The conclusions are often unwarranted.

Woods (Frederick Adams). "Mental and Moral Heredity in Royalty: a Statistical Study in History and Psychology, with 104 Portraits." New York (H. Holt), 1906. [Abstract in *Popular Science Monthly*, August, 1902–April, 1903. Brief abstract in *Psychological Review*, March, 1902.] The individuals are included in the study by a strictly objective plan. Attempt is made to reduce the subjective element to a minimum while grading them to a scale of ten, by averaging opinions of historians. Conclusion that heredity outweighs environment is arrived at by several statistical methods. The general method of "averaging opinions" is shown to be practical and to give orderly results, harmonious with other researches in heredity. Human heredity shown to be "alternative" (non-blending).

"The Great Men of France (XIXth Century)." From London *Times* in *Science*, January 11, 1907. Names were obtained by popular vote.

FREDERICK ADAMS WOODS

MASSACHUSETTS INSTITUTE
OF TECHNOLOGY

SCIENTIFIC NOTES AND NEWS

The Royal Society has awarded the Copley medal to Dr. George W. Hill, of West Nyack, N. Y.

Professor Theodore W. Richards, of Harvard University, has been elected to corresponding membership in the Royal Prussian Academy of Sciences of Berlin.

Sir Joseph Larmor, Professor Felix Klein and Professor H. Poincaré have been elected honorary members of the Calcutta Mathematical Society.

Lieutenant E. H. Shackleton, the antarctic explorer, has been created a knight by King Edward.

The first fellowship established under the will of the late Dr. Sorby, has been awarded to Dr. Jocelyn F. Thorpe, F.R.S., who will work on the chemistry of the imino-compounds.

Arthur M. Banta, Ph.D. (Harvard), has resigned the professorship of biology at Marietta College to accept a position on the staff of the Station for Experimental Evolution at Cold Spring Harbor, N. Y. F. H. Krecker, Ph.D. (Johns Hopkins), has been elected to the position at Marietta College.

Mr. Trygve Jensen, a graduate of the department of electrical engineering of the University of Illinois, has recently been awarded the prize offered by the Edison Medal Committee of the American Institute of Electrical Engineers. The title of Mr. Jensen's thesis is "The Operation of a 100,000-volt Transformer." The prize consists of a diploma and a cash award of $150.

The University of Kansas sent two collecting parties into the field last summer. One, consisting of Professors C. E. McClung, W. J. Baumgartner, R. L. Moodie, W. R. Robertson with Mr. Ward Cook, devoted itself to obtaining from the waters of Puget Sound an extensive collection of specimens for class use. These will be shared with the high schools and colleges of Kansas in the endeavor to secure as good teaching as possible. The other party, consisting of Mr. H. T. Martin and two assistants, secured a large and valuable series of fish specimens from the Niobrara of Kansas. Several new forms were obtained and much good material for further comparative study of known species.

The program of the meeting of the American Philosophical Society on November 19 consists of a paper, by Professor C. L. Doolittle, on Halley's comet, illustrated with lantern views.

At a meeting of the American Antiquarian Society, held at Worcester, October 20, Dr. W. C. Farabee, of Harvard University, presented a paper on "Some Customs of the Macheyenga Indians of the Upper Amazon."

Dr. William R. Brooks, director of Smith Observatory and professor of astronomy at Hobart College, delivered his illustrated lecture on "The Wonders of the Heaven," before the Buffalo Society of Natural Sciences, on November 5.

Professor Joseph Jastrow, of the department of psychology of the University of Wisconsin, has been appointed by the trustees of Columbia University to give graduate courses in psychology in that institution during the second semester of this year, and to deliver a series of eight public lectures.

Sir Augustus Waller delivered a series of lectures on the Hitchcock foundation at the University of California, beginning on September 18. The subject of the lectures was "Physiology the Servant of Medicine."

Professor Frederic S. Lee, of Columbia University, has recently given the following addresses: On October 22, at New Haven and Hartford, before the section on Hygiene of the Connecticut State Teachers' Association on "The Nature of Fatigue"; on November 3, at Burlington, at the opening of the fifty-seventh session of the College of Medicine of the University of Vermont, on "A Defense of Sanity," and on November 12, an address to the graduating class of the Training School for Nurses of the New York Infirmary for Women and Children.

Beginning Friday, November 12, Professor S. A. Mitchell, of Columbia University, gives a course of six lectures on "Modern Astronomy" in Philadelphia, for the University

Extension Society. The subjects are: (1) "The Birth of the Moon," (2) "The Light and Heat of the Sun," (3) "Astronomy at the North Pole," (4) "Eclipses of the Sun," (5) "Halley's Comet," (6) "Is Mars Inhabited?"

At the inauguration of the new rooms of the Royal Society of Edinburgh, November 8, Sir William Turner, president of the society, delivered the address, which was followed by a reception.

The eighty-fourth Christmas course of juvenile lectures, founded at the Royal Institution in 1826 by Michael Faraday, will be delivered this year by Mr. W. Duddell, F.R.S. His subject is "Modern Electricity," and the first lecture will be given on December 28.

There will be a U. S. Civil Service examination on December 15, to fill the position of entomologist in the Bureau of Science at Manila, with a salary of $1,600.

By an arrangement with the *Centrale Stelle*, Kiel, the Lowell Observatory has been made the telegraphic distributing center for planetary news in America.

The American Anthropological Association and the American Folk-Lore Society will meet in affiliation with Section H of the American Association for the Advancement of Science at the meeting to be held in Boston, December 27, 1909, to January 1, 1910. Members of these two societies and of Section H, who contemplate presenting papers at this joint meeting of anthropologists should send immediately titles and abstracts of papers to Dr. George Grant MacCurdy, Yale University, New Haven, Conn., who is responsible for the combined program.

Members of the American Association for the Advancement of Science who are affiliated with Section D, Mechanical Science and Engineering, are invited to contribute to the program of the section for the Boston meeting. Those intending to do so are requested to so advise the secretary, Professor G. W. Bissell, East Lansing, Mich.

The twenty-seventh stated meeting of the American Ornithologists' Union will be held at the American Museum of Natural History in New York City, beginning on the evening of December 6. The evening session will be for the election of officers and members, and for the transaction of routine business. Tuesday and the following days of the session will be devoted to the presentation and discussion of scientific papers and will be open to the public. Information regarding the meeting can be had by addressing the secretary, Mr. John H. Sage, Portland, Conn.

The annual meeting of the American Nature-Study Society will be held in Boston on January 1, 1910. The topic for discussion is the course in nature-study for elementary schools. Both the biological and the inorganic aspects of nature-study will be considered.

The American Society of Animal Nutrition will meet at Chicago on November 27, in connection with the International Live-stock Exposition. Dr. H. P. Armsby, of the Pennsylvania State College, will give the presidential address. Professor H. R. Smith, of the University of Nebraska, will present a paper on "The Value of Feeding Experiments to the Farmer" and the reports of several committees will be presented.

The ninth meeting of the Central Association of Science and Mathematics Teachers will be held at the University of Chicago on November 26 and 27. The work of this association is mainly concerned with the problems of the secondary schools in teaching science and mathematics. It developed the correlation of secondary school mathematics and originated the so-called "new movement" among physics teachers, and is now engaged in considering the fundamentals of the several sciences as presented in secondary schools. At the general session on November 26, Professor Chamberlin, of the University of Chicago, will give some account of his recent studies in China in an address entitled "Certain Features of China, Physical and Humanistic." Principal James E. Armstrong, of the Englewood High School, Chicago, will give some conclusions based upon four years' experience with segregated classes in high school, in an address, "The Advantages of Sex Segregation in High

School." Among other educators on the program are: Professor Richard E. Dodge, of Teachers College, Columbia University; Professor A. A. Michelson, University of Chicago; Dr. Norman A. Du Bois, Case School of Science, Cleveland; Professor Chas. R. Mann, University of Chicago; Dr. J. A. Drushel, Teachers College, St. Louis; Professor J. W. A. Young, University of Chicago; Professor Fred. T. Charles, University of Illinois.

At the invitation of the staff of the department of natural history of the College of the City of New York, twenty-two working biologists from the various laboratories of New York dined in the faculty dining rooms of the college on Tuesday evening, November 9. After the dinner, which was served by the college caterer, the men inspected the biological laboratories of the department. The following institutions were represented: the Rockefeller Institute, The College of Physicians and Surgeons, The New York Hospital, The College of Pharmacy, Cornell University Medical College, Columbia University and Barnard College.

A rubber pilot-balloon sent up on October 8 from Blue Hill Observatory to determine the air currents, was visible for one hour and ten minutes and in that time rose to a height of about 18,000 meters, or 11¼ miles. Probably this is the greatest height at which atmospheric movement has been observed in the United States, since the highest clouds measured at Blue Hill do not exceed 15,000 meters, or 9½ miles.

The magnetic survey yacht *Carnegie* had many distinguished visitors while at Falmouth, England, among them being the Earl of Plymouth, the Honorable W. Peel, Sir Arthur Rücker and Professor Arthur Schuster. The latter two gentlemen made official visits as members of the advisory board of the department of Terrestrial Magnetism of the Carnegie Institution of Washington. The magnetic data already secured on board the *Carnegie* have been communicated to the principal hydrographic offices and were presented by General M. Rykatscheff before the Russian Geographic Society, St. Petersburg, on October 27. The director, Dr. L. A. Bauer, returned to Washington on November 11. The *Carnegie* left Falmouth under the command of Mr. W. J. Peters, on November 8, bound for Madeira and Bermuda.

It will be remembered that the late Dr. H. C. Sorby, F.R.S., of Sheffield, bequeathed a sum of £15,000 to the Royal Society of London to be held in trust for the establishment of a professorship or fellowship for original scientific research, the testator expressly desiring the professorship or fellowship thus founded to be associated with the University of Sheffield. Accepting this trust, the council of the Royal Society appointed a committee to confer with representatives of the University of Sheffield with the view of drawing up a scheme for giving effect to the intentions of Dr. Sorby's will. A scheme, prepared by this committee for the establishment of a "Sorby Fellowship for Scientific Research" to be associated with the University of Sheffield, has now been approved and adopted by the council of the Royal Society, and by the senate and council of the University of Sheffield. The fellow will be required to carry out his research, when possible, in one of the laboratories of the University of Sheffield, and provision is made under the regulations for the setting aside of a sum not exceeding £50 a year to form an apparatus fund, from which grants may be made from time to time to the fellow for the purchase of special apparatus and material required in his research. The stipend of the Sorby Research Fellow will probably be about £500 per annum.

The geological department of the University of Wisconsin has recently completed a relief map of the state of Illinois for the University of Illinois, on a scale of five miles to the inch horizontally and 1,320 feet to the inch vertically. The low relief of the prairie region between the Mississippi, the Ohio and Lake Michigan, with the contrasting sharply cut stream valleys and gorges in the lead and zinc district in the northwest and the Ozark plateau extension in the extreme south are well shown on the map. The topography is based on the contour maps prepared for the

Chicago World's Fair and the topographic maps of the United States Geological Survey and the Mississippi River commission. Most of the geology is from the geological map prepared for the Illinois Geological Survey.

After making 15,000 tests on 50 railway bridges on the lines of eight different railroad systems of the country, Dean F. E. Turneaure, of the college of engineering of the University of Wisconsin, is now compiling data which it is expected will eliminate the element of guess work in allowing for speed strain in bridge design. Heretofore there have been few actual data on the comparative effects of speeds on the different parts of bridges, so that allowance for such strain had to be made largely by guess. A few experiments were made with machinery imported from Germany, including those of Dean Turneaure in 1907 on the St. Paul road, but the difficulty and expense prevented further investigation until Dean Turneaure invented a machine of his own for the work. This is an electrical instrument which makes an autographic record of every slightest bending, shortening or stretching of the part of the bridge to which it is attached, when a train is crossing the bridge. Twelve duplicates of the machine were made in the shops of the college of engineering, and used simultaneously on different parts of the bridge, giving accurate data for comparison. Since it seems likely that not all of the fund of $9,000 subscribed by American railroads to defray the expense of the investigation will be used in this series of tests, it is planned to start a second series of experiments involving a different feature.

Nickel and cobalt are not produced in large quantities in the United States, the domestic output of nickel in 1908 coming from only two or three places and that of cobalt from only one place. Both metals are produced by a lead company at Fredericktown, Mo., and some nickel ore was shipped from Bunkerville, Nev. Other nickel deposits are known in various parts of the country, but no work of importance was done on them during 1908. Some nickel salts were made at a New Jersey refinery from electrolyte solutions obtained in the refining of copper. In copper refining by electrolysis nickel contained in the raw copper anodes goes into solution in the electrolyte, and unless the solutions are changed before the amount of nickel reaches 1 per cent. of the solution, nickel is deposited with the copper. It is said that this causes the copper to lose some of its toughness. Before this factor in electrolytic refining was found to be serious it was impossible to make electrolytic copper equal to the best Lake Superior brands, but the refiners say that since this discovery they can make electrolytic copper equal to any other, and even superior to some in electroconductivity.

UNIVERSITY AND EDUCATIONAL NEWS

The provisions of the will of Mr. John Stewart Kennedy have not been officially announced, and the reports which have been published are not exactly correct. Mr. Kennedy bequeathed one half of his vast estate to public purposes. The greater part of this estate is to be divided into sixty-four parts, and the bequests have been made on the basis of these parts. Thus to Columbia University and the other institutions receiving the largest bequests are devised three of the parts, not $2,225,000, as has been stated. The announcement was based on the supposition that the value of these parts would be $750,000, and it is believed that this is a very conservative estimate. If certain of the heirs die without issue, the property bequeathed to them is to be divided into four equal parts to be given, respectively, to Columbia University, the New York Public Library, the Metropolitan Museum of Art and the Presbyterian Hospital of New York City.

It is reported by cablegram that Mrs. Francisca Speyer has bequeathed more than $8,000,000 to public purposes. The bequests include $1,000,000 to the Frankfort Academy of Social and Commercial Science, and $1,000,000 for the furtherance of the research into the subject of cancer and lupus.

Mr. William D. Sloane has given $150,000 to the College of Physicians and Surgeons of

Columbia University for an addition to the Sloane Maternity Hospital.

THE New York *Evening Post* states that the bequest of Dr. Levi Ives Shoemaker, of Wilkes-Barre, Pa., of $500,000 to the Medical School of Yale University will, at the expiration of a life interest, give the school an amount more than double its present funds, which, by the last report of the university treasurer, were $222,687.

DR. G. B. LONSTAFF, of New College, Oxford, has given £2,400 to the university for forming an additional endowment for the maintenance and support of the Hope department of zoology.

THE laboratory of physics of the University of Illinois will be formally opened on November 26. President Pritchett, of the Carnegie Foundation, will make the dedicatory address, preceded by short addresses by the governor of Illinois, the president of the board of trustees, the president of the university and Dr. A. P. Carman, professor of physics. At a subsequent session addresses will be made by Professor David Kinley, dean of the graduate school and Professor Arthur G. Webster, of Clark University. On November 27, the American Physical Society will hold its regular meeting at the university.

THE formal inauguration of Dr. Edmund C. Sanford as president of Clark College will be held on founder's day, February 1, 1910.

PROFESSOR CLARENCE E. REID, who for the last four years has been assistant professor of electrical engineering at the Case School of Applied Science, has been appointed head of the department of physics and electrical engineering at the Mississippi Agricultural and Mechanical College.

DR. G. C. FRACKER has resigned the chair of philosophy and psychology at Coe College to accept the chair of psychology and education at the State Normal School of Marquette, Mich., where he succeeds Professor L. S. Anderson, who has gone to the University of Illinois. Dr. F. S. Newell has been appointed to the position in Coe College.

AT the University of Birmingham Mr. J. S. C. Douglas has been appointed lecturer in pathology and bacteriology, and Mr. Leonard Doncaster, special lecturer in heredity and variation.

MR. GORDON MERRIMAN, of Trinity Hall, has been appointed to the studentship in medical entomology at Cambridge University, lately held by Mr. F. P. Jepson, of Pembroke College.

DISCUSSION AND CORRESPONDENCE

THE COMBINED COURSE LEADING TO THE DEGREES OF A.B. OR B.S., AND OF M.D.

THE combined course leading to the degrees of A.B. or B.S. and the degree of M.D. which is discussed by Professor Christian in his address at Leland Stanford University[1] is a topic of such importance that Professor Christian's comments ought not to go unanswered. His declaration that "These schools have succeeded in rendering the A.B. degree of less value and significance than formerly and have sacrificed one or two years of college work while seeking to conceal this fact by the award of the two degrees A.B. and M.D.," will hardly be accepted as a just and truthful statement of the facts, by the twenty-five or more institutions now offering the combined course. Those persons who maintain that the bachelor's degree should be awarded only to those students who have completed the rigid, classical four years' course of study formerly prescribed, may logically object to the substitution of science work for one half or more of this curriculum, such as has been permitted in Harvard University for many years. But this rigid, classical ideal was shattered more than thirty years ago by the institution of the elective system in Harvard University—a system which in one modification or another has come to be all but universal in our American universities.

Of the right of the fundamental medical sciences, anatomy, histology, embryology, physiology, physiological chemistry, bacteriology, pharmacology and fundamental pathology—to a place in the university curriculum

[1] SCIENCE, October 22, 1909.

there can scarcely be room for discussion at this time. Says Professor Christian in another part of his address:

There is no essential difference between the methods followed by the pathologist in his investigation and those followed by the zoologist in certain of his fields of work; the medical chemist uses the procedures of the organic chemist; the bacteriologist is an investigator in a special field of botany. That in the medical departments man and his diseases is the ultimate subject of study is no reason for regarding these studies as less cultural than other university subjects.

President Eliot has put the case of the medical subjects even more forcibly. He has said:

There is no line between cultural and professional subjects. There is absolutely no line. I read the other day an admirable definition by President Hadley of what we wanted the colleges to effect, not the professional school—presumably Yale College. He said we wanted to teach the college youth civic duty and religious earnestness, and health of mind and religious aspiration; he wanted to teach him public service as the root of American life and therefore of American education. Now, that is twice as gospel, gentlemen. It is the educational gospel. But, in my judgment, it is not the gospel of the American college only, it is the gospel of American education from the primary school through the professional school, and I know of no subject better adapted to develop the sense of civic duty, of public service, and of moral and religious earnestness than the subjects taught in the medical school.

If these things be true, if we accept the elective system, and grant to those sciences which constitute the first two years of the curriculum of all medical schools the right to a place among the sciences taught in the university, can there be any logical escape from the conclusion that if a young man elects these sciences during the junior and senior years of his college course, he must be granted a bachelor's degree on the successful completion of his four years of college work?

No—the combined course has not degraded, nor lessened, the significance of the bachelor's degree. Rather I am strongly inclined to believe, it has elevated and enlarged its significance. The student whose last two years of college work have been taken in subjects directly related to his chosen vocation, pursued with an enthusiasm and an earnestness born of a definite purpose is pretty certain to have attained to a higher degree of cultivation of his mental faculties—which is the chief end of any educational system—than is the student whose studies are not directed toward a definite purpose.

Has the combined course tended to degrade or lessen the significance of the degree of M.D.? If the requirement for admission to the medical school had been a bachelor's degree, then that charge might be justly brought against the combined course, but it is to be remembered that when this plan was first projected but a single one of the 160 or more medical schools in America exacted anything more than a high-school diploma. The Harvard Medical School and all the remainder of the list, excepting the Johns Hopkins Medical School, were on this basis. Of course two years of college preparation is not equal in value to four years, and it is in the highest degree desirable that a student should complete four years of college work, exclusive of the medical sciences, if his age and other circumstances permit him to do so. A large and an increasing number of students are meeting this higher requirement in all of the better medical schools, and every inducement should be offered to young men to complete a full college course before entering upon the study of medicine. But for a long time to come we shall have in this country a considerable number of men to whom the exaction of four years' requirement would mean deferment of their entrance upon medical study and practise beyond that age at which it is wise and best for them to begin their life work. As President Eliot has said: "If a young man takes his A.B. at twenty-two he can hardly hope to begin the practise of his profession before the age of twenty-six. That is quite late enough." Professor Christian has himself so well stated the objections to late graduation in medicine that it is perhaps unnecessary to discuss the subject further, but a specific case may serve to emphasize this point. My advice has been

sought within a few days by a young man of twenty-seven who is just entering upon his second year of college work. He is willing and anxious to pursue that course which is best for him as a preparation for medical practise. He came to inquire specifically whether he ought to complete his college course and secure his bachelor's degree before entering the medical school, or should he take up the medical subjects in the combined course next year. The first alternative would defer his entrance into actual practise eight years (including one year of hospital training), at which time he will be thirty-five years of age. He is securing in the two years of preparatory college work two majors of college physics (240 hours), four majors of college chemistry (he has had one year each of physics and chemistry in high school), one major of biology, and eleven majors of work in English, mathematics, psychology, German and French, and other non-scientific subjects. Is it wise to advise this young man to defer his graduation in medicine until he is thirty-five? If he were nineteen, twenty or twenty-one, the problem would be quite a different one. At such an age he could well afford to go the whole road. In such a case the work of the last two years in college should in most cases be along lines not related to the medical curriculum but rather in the humanities, to the end that the student may become a broadly cultured, scholarly man and citizen, as well as a thoroughly trained physician. Some additional work in chemistry—quantitative analysis—and in comparative anatomy, he should have, and especially should he carry on some piece of independent investigation in order to develop the power of accurate observation and of clear logical thinking which is the most essential qualification for the practise of medicine.

Professor Christian will be glad to learn that the hope in which he indulges "that the day will soon come when the higher degrees will be awarded for medical studies just as for other university subjects," has long since been realized. The day arrived some years ago when courses in anatomy, physiology, pharmacology, bacteriology, pathology and experimental medicine were made in the most complete sense university courses, in the University of Chicago. For over five years it has been possible for the graduate students in this university to secure the doctorate degree for research in any of these departments, and several Ph.D. degrees have been so conferred. I believe the same conditions obtain at the universities of Wisconsin, Nebraska, Kansas, California and other western institutions, in which institutions such departments have been organized in the university proper, where they rightly belong.

John M. Dodson

SCHOLASTIC COMPETITION

The earnestness and enthusiasm which competition has given to athletics invites serious consideration, as to how a similar competitive spirit may be stimulated in collegiate studies. The fixed standard serves to eliminate the lazy and stupid students, and requires a certain activity of the general mass; but does nothing to make the best men put forth their full powers.

Such prizes as have generally been offered, namely, medals, books or money, do not fire the imagination of a scholar, nor make his fellows cheer him. They are seldom worthy objects of prolonged mental discipline and self-denial. Further, the basis of their award is often so one-sided as to diminish their value in the eyes of students. It is power which should be stimulated and rewarded rather than a cut-and-dried record.

The value of the moments of great dramatic action in athletics has been recognized and is used as a stimulus for the prolonged and tedious training. From the nature of scholastic studies, these dramatic moments are fewer, but should therefore be made much of and multiplied where possible.

In a very few colleges there is a class of rewards which really stimulate the best scholars and enthuse their fellow students. While varying in different institutions and departments, they are always opportunities for widening the experience and increasing the knowledge of the successful competitors. I

refer especially to the expeditions sent out for collecting and study; a two-months' trip from a Massachusetts college to Cuba to make a geological collection, or from an Ohio college to the Maine coast for an anthropological collection, offers two or three of the best men an opportunity for broadening experience and further first-hand study; which is a fit reward for excellency in geology or archeology; and the men respond to it.

Of necessity the plans of such an expedition, when they are to serve as a stimulus to scholarship, must be carefully thought through. The membership must be limited to men who have earned the right. The field should be distant enough to be a new experience. The objects of the expedition must be broad enough to interest not only those who go, but their fellow students. The manner of life should be as untrammeled as practicable, camping if possible. In general, research work would be too technical for the main object of such an expedition; but it is rare indeed that two months of active work by a party of three or four fails to bring to light some new form, or make some concrete contribution to knowledge. And it is this possibility, like the vein of gold to the prospector, which urges the men ever on; and upon their return, it is the account of this success which brings the cheers of their fellows. This last is a very important part of an expedition, being the dramatic moment which completes the trip.

While such natural sciences as anthropology, biology, botany, geology and zoology most easily lend themselves to expeditions, other departments like economics, physics, chemistry, etc., can use them for study and accumulation of data if not for collecting. Languages and mathematics will find methods along different lines. But I believe that in all cases the prize which will stimulate the best scholastic work is to offer the successful competitors a broader opportunity, and an experience which will probably not come to him again in later life. It is a taste of the fruit which mature work in his field offers.

F. B. Loomis

Amherst College

HISTORICAL GRAPHICS

To the Editor of Science: The two recent letters in Science with the above title suggest the hope that many other teachers are presenting the personal and historical sides of their subjects along with the scientific and formal parts, and are using charts like those described. It would be well worth the time needed, to require students to make such charts for different subjects, suitable brief lists of names with dates being furnished them and proper scales being suggested. It is obvious that where it is important to note contemporary lives—as in studying Italian art, or the wars between England and France, or between the kings of Judah and Israel—such charts are practically indispensable. If it is desired to unite in one chart both duration, as of lives, and dates of events, it is sometimes better to put the time in a vertical column.

But do not let it be overlooked that we owe this ingenious device to the famous Dr. Joseph Priestley, F.R.S., the chemist, historian, political writer and theologian. In 1765 he published "A Chart of Biography" which ran through many editions, including one at Philadelphia in 1803. A similar idea was utilized in "A New Chart of History" in 1770, of which a fifteenth edition appeared in 1816. His "Lectures on History," 1788, and several times reprinted, are accompanied by a small specimen of each chart. In one place he says:

> The state of the world with respect to persons . . . may be exhibited with ease and advantage by means of *lines* and *spaces*. . . . Our idea of *time* is always that of a *line*.

The advantages are set forth at length. His original chart covered the period 1200 B.C. to about 1750 A.D. and had 2,000 names divided into classes, with dates and areas; durations that were certain were represented by full lines; uncertain periods by dotted lines. These principles were clearly applied in the "Biographical Chart" with fifty names prefixed to his voluminous "History and Present State of Vision, Light and Colors," 1772.

As Americans we have a special interest in the man, because of his association with Ben-

jamin Franklin, who suggested that he write a history of electricity and to whom he dedicated his "Description of a Chart of History," and because the later years of his life were spent in Pennsylvania.

CHARLES K. WEAD

THE ZIA MESA AND RUINS

IN Mr. Edgar L. Hewett's "Antiquities of the Jemez Plateau, New Mexico," page 45, the description of village No. 41 reads:

On a partially isolated bit of mesa about three miles west of Jemez is a considerable ruin, which does not bear evidence, however, of long occupancy. The summit of the mesa is without trees and almost without soil, and water must have been obtained from below. The walls of the ruin are well defined, and stand in place five or six feet in height; but they are formed of rough, loosely laid stones, and are extremely thin and unstable. They could not have been high at any time, as there is a marked absence of débris, and the dearth of pottery and kitchen refuse would seem to stamp the place as a temporary or emergency abode. The site is favorable for defense, and there are traces of defensive walls along the margin and the summit. The buildings are irregular in plan and comprise three groups, the full length of the groups being about 450 feet and width 350. . . . There appears to be no definite historic reference to this site.[1]

I wish to call attention to the last sentence quoted:

The archives at Santa Fé state that when Diego de Vargas Zapata Lujan Ponce de Leon, governor of El Paso and the Northern Province, made his first entrada northward in 1692 he found that the Zias and Santa Annas together had built a new village on Mesa Colorado (Red Mesa) and the Jemez, Santo Domingo and a few Apaches were fortified on the other mesa at the forks of the river. The Zias readily submitted but the Jemez were hostile. Their place submitted finally, October 26, 1692.[2]

Also when bringing the hostile pueblos under subjugation, Governor Vargas with 120 men joined the Queres under Chief Ojeda in an attack on the Jemez on July 21, 1694. While en route the Zia Mesa (Mesa Colorado) was captured, five men being killed. Then on July 24 they took the Jemez mesa-pueblo, called Mesa Don Diego. The fight here was one of the fiercest fought, the Queres did much in securing the place. Here Don Eusebio de Vargas, brother of the governor, distinguished himself. The Jemez lost 81 killed, 371 prisoners, the village was sacked and burned, 300 *fanegas* of corn were captured. The Jemez governor, Chief Diego, was surrendered, first condemned to be shot, but finally sent as a slave to the mines of Nueva Vizcaya; the Indians surrendered him, it is stated, saying that he had been the cause of the trouble. The prisoners, in part, were allowed to go back to Jemez and build on the old site in the valley, if they would promise to aid in the wars when needed. Their wives and children were kept as hostages till after the capture of San Ildefonso, which was then still holding out against the Spanish authority.[3]

The village on Mesa Colorado referred to in the archives is undoubtedly the ruin No. 41, mentioned by Mr. Hewett and also by Mr. Holmes. The writer has often visited the mesa and village in question. The rocks of the mesa are almost blood red in color, so red that even the walls of the writer's office in the Jemez village three miles distant were caused to have a reddish glow from the reflected sunlight in the early morning hours. There is no other mesa in the vicinity on which a village-ruin is situated, except the one at the forks of the river on which the old Jemez village was located. Furthermore, the Jemez people call the Red Mesa the Zia Mesa to-day; and the Zias themselves say that their people once lived on it. The ruin on it, I reassert, is undoubtedly the Zia pueblo on Mesa Colorado mentioned in the Spanish records.

Note.—In all the archeological notes on the Jemez region there seems to be no mention of the remains of an ancient reservoir back of the white buttes at the mouth of a canyada that comes down from the foothills and enters the valley-flat adjacent to the Zia Mesa. This reservoir doubtless supplied the village with water for drinking purposes at times.

[1] Smithsonian Institution, Bureau of American Ethnology, Bulletin 32, pp. 45–6. Also see "Notes on the Jemez Valley, New Mexico," by W. H. Holmes, *American Anthropologist*, Vol. I., No. 2, April–June, 1905.

[2] Also see Bancroft's "History," the volume on New Mexico and Arizona.

[3] "Archives, New Mexico," 158–162.

Also no reference seems to be made of the ancient irrigating ditch that now skirts the bluffs east of the Jemez River, some twenty-five feet above the present ditch. Also no mention has ever been made of the petroglyphs on "red rock" in the valley about a mile north of the present village of Jemez. Here are drawings of deer, lightnings, snakes, the sun and moon, Montezuma and the footprints of "the great road-runner."

Albert B. Reagan
Nett Lake School,
Orr, Minn.

MAP OF MASSACHUSETTS WANTED

To the Editor of Science: The U. S. Geological Survey published in 1889 a four sheet map of Massachusetts and Rhode Island, scale $1/250000$ contour interval 100 feet, forming a sheet 48×30 inches, and engraved by Julius Bien. Any person possessing a copy of this map and willing to loan the same for a short time would confer a great favor by communicating with the subscriber.

B. K. Emerson
Amherst College

THE BERKELEY ASTRONOMICAL DEPARTMENT

To the Editor of Science: It has recently come to the attention of the Berkeley astronomical department of the University of California that Dr. See's reference to it (p. 479 of the issue of Science of Oct. 8, 1909) has created an erroneous impression concerning the connection of the department with his recent theories of cosmogony. This note is to point out that the Berkeley astronomical department has, in no way, either approved or disapproved them. Its attitude has been entirely neutral, as is evidenced by several newspaper interviews, in which it has always been definitely stated that the department would be in no position either to affirm or to refute any of Dr. See's theories until the completed work becomes available. This completed work has not yet appeared.

It is to be added that from June, 1908 until August, 1909, Professor Leuschner, director of the students' observatory of this department, was abroad on leave and that the writer, as acting director, is entirely responsible for all matters emanating from here during that interval.

R. T. Crawford
Berkeley Astronomical Department,
University of California,
November 6, 1909

SCIENTIFIC BOOKS

Foundations of American Grape Culture. By T. V. Munson, D.Sc. Denison, Texas, T. V. Munson & Son. 1909.

The colossal work of Dr. Hedrick and associates of the Geneva (N. Y.) Agricultural Experiment Station (already reviewed in Science)[1] has been of inestimable service in furnishing a ready means of identification of grape varieties under cultivation, by means of superb colored illustrations and detailed descriptive matter. That volume is mainly devoted to results of tests and observations at the station on a very wide range of cultivated varieties, and does not assume to discuss botanical relations or the subject of interbreeding, except as standards of reference.

Those who have for many years watched the determined, painstaking labors of Dr. Munson, in Texas, have anticipated pleasure and profit from the monument he was expected to erect in the form of a book recording the outcome of his patient work and great sacrifices to compass the production of advanced types of grapes in the arduous process of breeding for quality.

"Foundations of American Grape Culture" comes as a veritable boon to many who owe its author much for previous aid and encouragement in the tedious and unremunerative practise of grape breeding. It is so filled with meat, so well and compactly arranged and thoroughly indexed, so copiously illustrated with most excellent reproductions from life, and so thoroughly digested, that it is impossible to characterize its contents in a sentence. The volume is remarkable in breadth of scope, completeness of treatment and wealth of detail, yet in clearness, conciseness

[1] "The Grapes of New York."

and effective generalization it is no less conspicuous. The botanist, culturist and interbreeder will each and all find the latest word from an adequate authority whose conclusions are convincingly stated with all the evidence in plain view. The value of the conclusions, aside from the high reputation of the author, is made manifest by a vast accumulation of facts well classified in the text, and by 86 full-page half-tones from nature photographs and other appropriate illustrations.

These reproductions of seed, wood, leaf, flower and fruit, executed with consummate skill of photographer and printer, under the jealous scrutiny of Dr. Munson, are far beyond anything heretofore brought out in black and white in this line.

Preceded by a choice portrait of the author, as a frontispiece, followed by a dedication in form of an original poem, the preface states succinctly the reasons which necessitate founding American grape culture upon the native species as a base. A modest review of the author's lifetime work in this field, a clear statement of the ideals to be sought in the compounding of strains and a list of vineyards and nurseries used as experimental grounds during more than thirty years of observation, culture and breeding, fill out the introductory pages.

Chapter I., of 101 pages, on the Botany of American Grapes, is replete with information, and constitutes a contribution of great importance to science. This has the merit of presenting a very complex subject, not without autocratic decisions, but always with clear indication of the facts which justify such conclusions in the author's mind. Dr. Munson's observations have been more wide-spread and continuous, his studies more profound and his methods more precise than other investigators in this field. His revised scheme of classification here published may therefore be taken with confidence for just what he regards it—an attempt to arrange the species of grapes in a scheme of classification which shall, as nearly as possible, group them in accordance with natural relationships, that is to say, "in approximate chronological order of development," the unknown "chronology and actual genealogy" being inferred from similarities in form and especially from biological similarities. As such, this is a decided advance in systematic botany, although it is confessedly and approximately framed primarily for the guidance of practical culturists instead of philosophic students.

In this chapter the 28 species allowed (26 American, 2 foreign) are carefully described in minute detail, by botanical characters, with typical full-page illustrations, followed in each instance by very full "Viticultural Observations and Remarks," giving a vast amount of information regarding growth from seed and cuttings, foliation, inflorescence, resistance to disease, natural and artificial crosses and hybrids.

Chapter II., Breeding of Varieties of Grapes, covers 27 pages of valuable discussion on thoroughbred vines, selection of parents, order of germination, blooming periods, length of life, soil adaptability, climatic range, longevity, market value, analyses of fruit, graft stocks, selections of varieties for breeding north and south, for wine or table use, description of ideal variety, directions for crossing and hybridizing, collecting and preserving pollen, labeling seeds, planting seeds, care of seed-beds, transplanting, nursery treatment, and much valuable suggestion concerning allied subjects. Several tables of great interest are interspersed, making this chapter a most profitable mine of information of original character.

Chapter III., of 74 pages, arranges alphabetically by mother species the prominent varieties of grapes, discussing each very fully by descriptive text and full-page illustrations, showing the pedigree clearly and all details of origin, constitution and other information needed by growers.

Chapter IV., Adaptation of Varieties, treats of resistance to cold, heat, wet, drouth, soils, insects, fungi, followed by Select Lists of Varieties for Various Regions, giving a complete outline of distribution in eight zones. Of this arrangement, Dr. Munson justly remarks: "It is the opinion of the writer that this chapter is one of the most valuable pieces of grape literature ever presented to the prac-

tical grape-growers of the United States." At the close of the chapter is given a list of some of the best tested resistant graft stocks.

Four more meaty chapters on Practical Grape Growing are condensed in 24 pages. Chapter V. treats well of culture from the seed to fruiting, including selection and preparation of soil, choice of varieties, planting, trellising, pruning and training, fertilization, etc. Chapter VI., on Protection from Insects and Fungi, discusses preventive measures, including grafting on resistant stocks, spraying and other remedies, with brief descriptions of enemies to the vine. Chapter VII. is short and crisp, dealing with marketing of the crop, only touching on wine and brandy, but giving some space to the manufacture of grape juice, raisins, jams and jellies. Chapter VIII. gives important hints on the selection and treatment of vines for fruit, adornment and other home uses.

In the matter of indices, often lacking or deficient in works of this class, the author merits high commendation. He has placed at the close of the volume no less than five adequate synopses, as follows: (1) List of Illustrations, with 97 entries, italics being used to designate plates of specific types; (2) Synopsis of Chapters, a complete table of contents, itemized fully; (3) Index of Species and Varieties (211, in all, described in the work); (4) Index of Topics, a general index, exclusive of species and varieties; (5) List of Tables. There are ten of these, segregating statistics of importance, chiefly original with the author.

Thus compressed in 252 pages 7½ inches by 10½ inches, in a well-bound volume, with clear sharp type impressed on good heavy paper, the well-known author has met his eager public in most commendable dress. This outcome of his zeal and patience, measured from any view-point, must long be regarded as a model of its kind. Every new experimenter with grapes is set a quarter century ahead by the knowledge here vouchsafed, and the record of the author's achievement must serve as inspiration to a host of earnest students in the same field. The book brings into clear perspective for the first time the full measure of the scientific work of Dr. Munson. Its influence upon the development of viticulture the world over will be felt even more strongly by future generations.

Theo. B. Comstock
Los Angeles, Cal.

Exercise in Education and Medicine. By R. Tait McKenzie, A.B., M.D., Professor of Physical Education, and Director of the Department, University of Pennsylvania. Octavo of 406 pages, with 346 illustrations. Philadelphia and London, W. B. Saunders Company. 1909. Cloth, $3.50 net; half morocco, $5.00 net.

This book represents a distinct advance in the literature on physical exercise. It is well written, and interesting. It contains a good deal of material of scientific value. The various chapters are well supplied with first-class illustrations, some of which are from the author's own work. McKenzie's high rank as a sculptor is shown in the artistic features of these cuts. The text contains numerous references to the sources from which the author draws material. These references are ample for the general reader, though not sufficiently explicit for the investigating student.

The contents of the book are as follows:

Part I.: Exercise in Education—Chapter I., The Definition and Classification of Exercise; Chapter II., The Physiology of Exercise; Chapter III., Massage and Passive Motion; Chapter IV., Exercise by Apparatus; Chapter V., The German System of Physical Training; Chapter VI., The Swedish System of Gymnastics; Chapter VII., The Soft Business of Japan; Chapter VIII., Age, Sex and Occupation; Chapter IX., Playgrounds and Municipal Gymnasiums; Chapter X., Physical Education in Schools; Chapter XI., Physical Education in the College and University; Chapter XII., The Physical Education of the Blind, and Deaf Mute; Chapter XIII., Physical Education of Mental and Moral Defectives.

Part II.: Exercise in Medicine—Chapter I., The Application of Exercise to Pathogenic Conditions; Chapter II., Flat-foot and its Treatment; Chapter III., The Cause and

Treatment of Round Back, Stooped and Uneven Shoulders; Chapter IV., Scoliosis, its Causes, Varieties, Diagnosis and Prognosis; Chapter V., The Treatment of Scoliosis; Chapter VI., Exercise and Athletics as a Factor in Disease of the Circulation; Chapter VII., Obesity—its Cause and Treatment; Chapter VIII., Other Diseases of Nutrition; Chapter IX., Exercise in the Treatment of Nervous Diseases; Chapter X., The Treatment of Locomotor Ataxia by Exercise.

In reading the preface and looking over the table of contents one is struck with the fact that the author has planned to reach a wide range of readers, and for that reason has brought together a variety of material that is not usually so associated. He states in the preface that "the following pages are addressed to students and practitioners of physical training; to teachers of the youth; to students of medicine and to its practitioners, with the purpose to give a comprehensive view of the space exercise should hold in a complete scheme of education and in the treatment of abnormal or diseased conditions." A single text must be popularly written if it is planned for the student and practitioner of physical training; the teacher of the youth; and for the student and practitioner of medicine. The technicality of the average medical treatise is unintelligible to the average teacher of the youth or student or practitioner of physical training, and the usual presentation of the principles and practise of physical training contains more or less that is technical to all but the student and practitioner of physical training. Dr. McKenzie has succeeded in presenting Part I., Exercise in Education, with but little technicality, and Part II., Exercise in Medicine, with only moderate technicality. The book, therefore, is a popular book. It is, also, to some degree, a reference book.

On page 33 it is stated that ". . . in every course of athletic training the blood is still further thickened by restricting the amount of fluid ingested to replace evaporation." Dr. McKenzie takes the position that "condition" is the result of a "drying out" of the tissues and a thickening of the blood. This is the point of view of the trainer, but it is a deduction which is hardly justified scientifically. It is true that exercise increases the specific gravity of the blood somewhat, but so does sleep. The ingestion of food and the progress of the day decreases the specific gravity. One can hardly draw relevant conclusions from such data. Furthermore, the present tendency on the part of trainers is to break away from strict water restrictions and the success of those trainers has been as great as under the so-called tissue-drying process.

Page 35, "milometers" should read "millimeters" (mercury).

The reasons assigned for blood pressure changes in the chapter on The Physiology of Exercise are almost entirely mechanical. The influences of the vaso-motor reflexes seem not to have been considered.

Page 39, ". . . in fatigue, the will tires long before the contracting power of the muscle is lost." Lee states that "the former and still common idea that the brain and spinal cord are readily fatiguable, and in fact are the first part of the individual to succumb in a contest, seems not to be justified by the experiments of Hough, Storey, Woodworth, Joleyko, Kraepelin and others."[1]

Page 42, "The men were then wrapped in blankets . . . and showed a further loss (in weight). In no case was any gain found." Dr. McKenzie should have given his series of experiments a fuller consideration. There is back of the sentence "in no case was any gain found," an interesting discussion and investigation of the question as to the possibility of a gain in weight from inspired oxygen after extreme losses in weight during strenuous exercise.

Pages 126 and 129. A reference or an account of the researches on which the results are based should accompany the very interesting and valuable tables classifying athletic games and exercise, and giving their influence on blood pressure.

[1] "Physical Exercise from the Standpoint of Physiology," Frederic S. Lee, *Amer. Physical Educ. Review*, April, 1909, p. 5.

Page 142. The sand box is recommended for playgrounds. I think there is no other single feature that figures in the equipment of a playground that even approaches the sand box in its unhygienic, bacteriological and parasitic possibilities.

Page 167. Dr. McKenzie advises the use of floor sockets for fixing apparatus like the horse, parallel and horizontal bars on the floor of the exercising hall. It is only fair to state that a number of men have found or judged this device to be less convenient and utilitarian than the old movable apparatus. The experience at Pennsylvania, however, has been satisfactory.

Page 191. It is stated that summer courses in physical instruction are given at the College of the City of New York. This is a mistake.

Part II., Exercise in Medicine, contains much that interests the non-medical reader. It is rather too popular and brief for the specialist or general practitioner concerned with the various diseases discussed. It contains very little which the "teacher of the youth" would be expected to apply. The average "student and the practitioner of physical training" who has had no medical experience should not attempt the treatment of medical cases unless under the direction of a competent physician. "Round back and stooped and uneven shoulders" are not necessarily medical; but scoliosis and locomotor ataxia are samples of abnormal conditions which the non-medical man would do well to leave alone—unless he has a training and an experience like that of Bolin.

But I take it Dr. McKenzie has not attempted to prepare a text-book for such readers, but rather to present a discussion which will show them the relation of exercise to the treatment of various diseases so that they may secure an intelligent sympathy for the logical and common-sense principles which he has brought together.

In conclusion it may be said that in its "purpose to give a comprehensive view of the space exercise should hold in a complete scheme of education and in the treatment of abnormal or diseased conditions," this book is a success.

THOMAS A. STOREY

Second Appendix to the Sixth Edition of Dana's System of Mineralogy. By EDWARD S. DANA and WILLIAM E. FORD. New York, John Wiley & Sons. 1909.

Dana's "System of Mineralogy," as a standard work of reference, has become so indispensable to every one interested in minerals that all additions to it, which tend to bring the work up to date, will always be welcomed. Ten years have elapsed since the first appendix appeared and this period has been one of great activity in mineralogical research. Many new mineral names have been proposed, and new occurrences, forms and physical properties of known species have been described. This second appendix contains an excellent bibliography of mineralogical literature issued during the ten years with a concise statement of the subject matter of each article and quotation of new forms, and complete descriptions of all minerals that have been announced as new species; consequently references to several hundred minerals are included in the book. Over two hundred new names have been proposed for minerals and from this number the authors have selected about sixty, on account of their better descriptions, as meriting the distinction of being new species. As to this limited selection from so many new compounds, some disagreement with the authors may arise, but they feel justified in relegating to subordinate rank most of the so-called new minerals, because of the insufficient data to establish their recognition as species.

The appendix is similar in size, binding and arrangement of contents to the first one, issued in 1899. The minerals are arranged in alphabetical order with all of the new names in heavy-faced type, but in the classified list only those considered as new species are in bold type. The great task of preparing this appendix was begun by the senior author and continued by him until 1906 when his health compelled him to give up the work, and it devolved upon the junior author to complete the book to the present year, which he has ably done.

Every scientific investigator will deeply regret the loss of Professor Dana from active work, and it is the heart-felt wish of his legion of friends that he may speedily regain his health and strength. With his retirement, and

the lamentable departure of his brilliant colleague, the late Professor Penfield, mineralogical science has lost two of its foremost and ablest promoters.

ARTHUR S. EAKLE
UNIVERSITY OF CALIFORNIA

SCIENTIFIC JOURNALS AND ARTICLES

Journal of Economic Entomology, Vol. I., February, 1908–December, 1908; Vol. II., February, 1909–December, 1909.

It is not often that it is possible to write a review of a periodical with its numerous contributions of varying merit, and it is possible in this case only because it is a growth and illustrates the growth of a science and its development along practical lines. It is stated on the cover that this is the official organ of the Association of Economic Entomologists, and any note of the *Journal* must contain some record of this association.

It was at Toronto, in August, 1889, that the Association of Economic Entomologists was born at the call of the late Dr. James Fletcher, with the extremely limited membership of twenty-two, which elected the late Dr. C. V. Riley, then entomologist to the U. S. Department of Agriculture, as its first president, and the writer of this review as its secretary. During the twenty years following that initial gathering, the writer has been in attendance at most of the meetings, and has seen its membership increase until, under new restrictive laws, there are 119 active, 125 associate and 47 foreign members—a total of 291. More entomologists here, more or less engaged in active research work, than the wildest dreams of the founders considered possible at the initial meeting.

From the beginning, the relation of this association with the U. S. Department of Agriculture was close. Small as the entomological division of the department was at that time, compared with its present-day development, it represented to the rest of the country a source of authority and information which, in all subsequent development, has not lessened in value, even if not as dominant now as then.

Dr. Riley, as the first president of the association and one of its most active promoters, was naturally interested in securing publicity to its transactions, and reasoning rightly that any force that made for impressing upon the agricultural public the value of entomological work was worth using, he induced the then commissioner of agriculture to authorize the publication of the proceedings of the association in *Insect Life,* where the record of the organization takes up a part of pages 87 and 88 of Vol. II., and the records of the first annual meeting take up pages 177–184 of the same volume. During the continuance of *Insect Life,* an ever-increasing space was occupied by this association until, in 1893, at the fifth annual meeting, an entire number of *Insect Life,* of about 145 pages, was taken up by its records. After the discontinuance of this periodical, the records of the association were published in the bulletins of the department, and Dr. L. O. Howard, who succeeded Dr. Riley as head of the entomological division, followed the policy of his former chief in recommending the publication of the proceedings of the association by the department.

But, as the membership increased and as, to speak metaphorically, the association felt its oats, the tendency was to divorce the association, loosely constituted as it was and in no position to assume publication, from the department and to throw it upon its own resources. It solved the problem of support for the proposed journal by the organization of a publishing company which assumed financial responsibility, while the association furnished material to be published, as well as the subscribers.

The writer was one of the conservative members who, by age and long habit, was wedded to past methods, and who opposed the establishment of the *Journal of Economic Entomology.* It gives him pleasure to admit that he was all wrong; that the establishment of the *Journal* was justified by results, and that the cause of economic entomology was materially advanced by the action of the association in 1908.

The *Journal of Economic Entomology* under the editorship of Dr. E. Porter Felt, of Albany, N. Y., and under the business management of Professor E. D. Sanderson, of Durham, N. H., has been a power for the development of economic entomology. It has not only published the records of the meetings of Chicago in 1907, and at Baltimore in 1908, but it has secured for economic workers throughout the country, records of progress throughout the season, and it has made possible the early publication of results that were of sufficient importance to warrant the attention of other workers along similar lines. It would be easy to criticize adversely individual publications in this journal, and to find fault with details of management, but in that it would share only the fate of other periodicals that depend upon individuals for their contents. The *Journal of Economic Entomology* has not only justified itself during the nearly two years of its existence; but, in the opinion of one of its opponents, has done excellent work in the advancement of the science whose records it publishes.

John B. Smith

Rutgers College,
New Brunswick, N. J.

SPECIAL ARTICLES

ON THE PLANT GEOGRAPHY OF THE CHIRICAHUA MOUNTAINS

The Chiricahua Mountains[1] of southeastern Arizona extend almost due north and south for some 50 miles from Fort Bowie to a point near College Peak, and within 15 miles of the Mexican Boundary, with a maximum width at Paradise of 18 miles. On their west lies the broad and level Sulphur Springs Valley at about 5,000 feet altitude, on their east the trough-like San Simon Valley drops to nearly 3,500 feet. The highest part of the range extends from Paradise to Rucker Canyon, consists of five or six more or less elongated forest-covered peaks whose axes lie in a north-east-southwest direction, and rises in Cave Peak to an altitude of about 9,700 feet above sea-level.

As one might expect, the tree growth is quite similar to that recently given by Mearns[2] for several mountain ranges near the international boundary of this region. Of the 54 species (including a few shrubs) mentioned as occurring about 12 or 15 mountain masses of his "Elevated Central Tract," 48 are found in the Chiricahuas alone. He enumerates 137 arborescent species along the boundary from Texas to the Pacific Coast. In the Chiricahuas were found, exclusive of succulents and Liliaceæ, a total of 124 species of trees and shrubs. These consist of 111 angiosperms and 13 gymnosperms, all the latter being trees except *Ephedra* sp., and all evergreen. Of the angiosperms, 35 are trees and 76 are shrubs, making a total for the mountains of 47 trees and 77 shrubs. Ten of the latter are suffrutescent composites, probably all more or less evergreen, at least when sufficient moisture is available. Of the remaining shrubby species, 39 are deciduous and 16 evergreen, while 12 in this respect are unknown to the writer. Thus the total of known evergreens is 47, that of deciduous species, 65. Other species will be found, but they will probably not materially alter these proportions.

This does not, however, give the key to a true, general picture of the floral geography. This must rather base upon the number, size and distribution of the individuals composing the more prevalent species. From this viewpoint, leaving out of consideration the winter-dead ground-cover of perennial and annual grasses and herbs, the evergreen character is altogether dominant. The Lower Sonoran zone, characterized by its cacti and thorny shrubs, often drouth-deciduous, touches the mountains only at their eastern base and both ends. The Upper Sonoran completely encircles them in a broad belt of evergreen brush land, with the oaks as leading species, corresponding to one of the types of Schimper's Immergrünes Hartlaubgehölze. This extends well into the Transition zone, and here mingles with the

[1] In 1906 and 1907, ten months were given to the exploration of this range, some 1,600 miles covered within its bounds, and about 1,050 species of plants collected. Undoubtedly many other higher plants may be found.

[2] "Mammals of the Mex. Bound. of the U. S.," Part I., Bull. 56, U. S. Nat. Mus., 1907.

outposts of the tall coniferous forest, which through the Canadian and Hudsonian zones envelops all the remainder of the range with a mantle of needle-leaf evergreen differing only in its much deeper hue from the light green of the largely sclerophyllous broadleaf brush-woods of the lower slopes.

The larger species most characteristic of the several zones are as follows: Lower Sonoran or Desert Zone—*Acacia constricta* Benth., *A. greggii* A. Gray, *Prosopis velutina* Wooton.[3] Upper Sonoran or Oak Zone—*Quercus oblongifolia* Torr., *Q. emoryi* Torr., *Q. toumeyi* Sarg., *Juniperus monosperma* Engelm., *Prosopis glandulosa* Torr.[3] Transition or Pine Zone—*Pinus chihuahuana* Engelm., *P. mayriana* Sudw., *P. cembroides* Zucc., *Quercus hypoleuca* Engelm., *Q. reticulata* H. B. K. Canadian or Fir Zone—*Abies concolor* (Gord.) Parry, *Pinus arizonica* Engelm. Hudsonian or Spruce Zone—*Picea Engelmannii* (Parry) Engelm.

Other prominent species are *Quercus arizonica* Sarg. and *Juniperus pachyphlœa* Torr., which are practically coextensive throughout the Upper Sonoran and Transition zones. In like manner, *Pinus strobiformis* Engelm. links and extends over the Canadian and Hudsonian zones, becoming increasingly abundant toward the summits, while *Pseudotsuga taxifolia* (Lam.) Britton is present here and downward, reaching the remarkably low altitude of 6,500 feet on residual north slopes in several instances.

If three maps were to be drawn of this mountain range, to show the three chief features of its floral geography, the first would give the several altitudinal zones, both in succession and relative limits somewhat as outlined by Merriam for San Francisco Peak in northern Arizona.[4] The chief differences between the two mountain masses are: (1) The absence of the two uppermost zones of Merriam from the Chiricahuas, due to insufficient elevation. (2) The absence in the San Francisco Mountains of the evergreen oaks, whereas in the Chiricahuas the pinyon of the former is to a great extent replaced by oak, and should be designated the oak zone or oak-pinyon zone.

TABLE OF ALTITUDES

Zones of San Francisco Mts. (Merriam)

Desert Area	4,000–6,000 feet
Pinyon Zone	6,000–7,000 feet
Pine Zone	7,000–8,200 feet
Balsam Fir Zone	8,200–9,200 feet
Spruce Zone	9,200–10,500 feet
Timber-Line Zone	10,500–11,500 feet
Alpine Zone	Above 11,500 feet

Zones of Chiricahua Mts.

Desert Area	Below 4,500 feet
Oak Zone	4,500–6,000 feet
Pine Zone	6,000–7,900 feet
Fir Zone	7,900–8,900 feet
Spruce Zone	Above 8,900 feet

The San Francisco altitudes represent mean elevations of the limits of the several zones. The lower limits of the Chiricahua zones are approximate averages of the lowest points of extension on residual slopes of the species or groups of species for which the respective zones are named.[5] The upper limits, as given, merely coincide with the lower limits of the next higher zones. This will partly account for the lower elevation of the Chiricahua zones, while in part it may be due to lower base level (smaller land mass)[6] despite the counteractive effect of lower latitude. The zones in reality overlap, but on paper we have thus at least their true lower limits. Their upper limits fall into other zones or else are not reached. For example, the four or five larger pines extend from a limit of 6,000 feet to the ultimate summits of the range, on sunny aspects covering both the fir and the spruce zones completely. In order to admit the latter two, the former must be restricted. Similarly the oak zone, equivalent to the lower portion of the total oak area and devoid

[3] Often considered varieties of *Prosopis juliflora* (Sw.) DC.

[4] North American Fauna No. 3, U. S. Dept. Agr., pp. 7–17, 1890.

[5] These altitudes were obtained by aneroid loaned by the Desert Laboratory of the Carnegie Institution, frequently checked by the new bench marks of the U. S. Geological Survey.

[6] See Lowell, *Century Magazine*, March, 1908.

of the larger pines, remains not always below 6,000 feet, nor the desert area below 4,500, but, under favorable (or unfavorable!)[7] conditions they may raise long tongues into the upper zones. Thus near Paradise certain points carry the former to a height of 8,700, the latter to 6,250 feet, mainly dependent upon aspect (slope exposure) modified by gradient,[8] and secondarily upon character of the rock and soil and other conditions. Also, in fixing the lower limits at their first appearance on residual slopes, we avoid the mere fringes of species that normally belong to higher zones, but follow the canyons and watercourses down and often far out into desert and grassy plain.

The second map, showing the vegetation as governed by aspect, would have the appearance of a veritable crazy-quilt in its patchwork of many small areas of different color. By far the larger part of the montane area is composed of slopes facing either north, east, south or west, or in intermediate directions. Given the same altitude, locality, rock and soil, each aspect supports a plant society differing in some degree from those of other aspects. The difference may consist in kind, number or relative proportion of species, or merely in number, relative abundance, size and thrift of individuals, usually two or more of these combined. In view of many other influences that may be at work, such as seepage, exposure to local atmospheric currents, number and size of boulders present, physical constitution and relative abundance of rock and soil, presence of animals or insects, the greatest caution is constantly necessary in attributing the differences to the proper controlling cause. However, it may be stated that, given otherwise similar conditions, the more directly one slope faces southward, and the other northward, the greater is the difference between their plant societies.

The floral difference between two small contiguous slopes of equal gradient and similar limestone soil at 5,500 feet near Paradise,[9] directly facing each other, one north, the other south, may serve as a simple example of the influence of aspect: The north slope supports a dense, shrubby growth of *Ceanothus greggii* A. Gray, interspersed with *Cercocarpus breviflorus* A. Gray, *Viguiera helianthoides* H. B. K., and numerous smaller plants, from which grasses are practically absent. The south slope is entirely devoid of trees and shrubs, dotted with *Croton corymbulosus* Engelm. and covered with grasses, among which no less than three species of *Triodia* are prominent.

These slopes for the greater part are rather sharply bounded by adjoining and opposing slopes and canyon bottoms. But, unlike the more or less insensible transition between one altitudinal zone and another, the tension lines between adjoining plant societies follow these topographic boundaries, such as crests of ridges, angles of V-shaped gullies, or sides of canyon bottoms, and usually their degree of definiteness is in direct proportion to the sharpness by which such boundaries are marked.

The third map would divide the mountains, without regard either to altitude or to aspect, into more or less irregular areas both large and small, their number dependent upon the degree of intensity employed, based upon the geologic origin and character of the rock and soil. The following main divisions may be made:

I. Transported Soils.
II. Residual Soils derived from
 1. Limestone.
 2. Recent eruptives.
 3. Other rocks.

The small total area of transported soils is confined to outwash slopes, canyon bottoms, and small mountain parks. They support floral elements either quite peculiar to themselves, or else derived from two or more residual societies. For the present are made only the three divisions of residual soils that show the greatest differences between their plant societies as indicated by their trees and shrubs. Each division or group of societies is found to be peculiar to a class of rocks and residual soils of its own. Further, the so-called tension lines between these societies or groups of

[7] Spalding, *Plant World*, XI., p. 213, 1908.

[8] See Merriam, N. A. Fauna No. 3, p. 27, Pl. II.

[9] Designated as Slopes I and III in exsiccati distributed.

such are usually marked with great definiteness and bear no relation to aspect. Moreover, these sharp boundary lines coincide throughout with the more plainly marked surface contacts and boundaries of such geologic formations. Cases occur in which, if two quadrats of 1,000 square feet each were laid off, each on a separate formation,[10] but adjoining one another on one side and on the contact line, not a single woody species would be common to both quadrats, although several such might be found on either.[11-12] The first class of areas is composed of limestone, the second and smallest in total extent of basalt, and the third and by far the largest, of older igneous and metamorphic rocks, predominant among which are andesite, rhyolite, granite and quartzite.[13]

The second division is practically confined to certain volcanic outbursts in the eastern and southern parts of the range, but certain spots also occur on its west side. The comparatively recent origin of these is shown by the fact that on the rim of a former crater were found volcanic bombs in a state of excellent preservation and fragments of lava that still bore plainly the marks of former plasticity. Grasses and herbs cover these hills, but they are characterized by the almost complete absence of tree and shrub growth. The adjacent hills of andesite and rhyolite bear with the same aspect and general altitude of 5,000 feet the usual evergreen oaks and junipers. Whether comparative age of the formation is a factor or not, the cause plainly lies in the substratum.

The first division is distinguished from the great composite third mainly by species of smaller stature and leaf surface, *i. e.*, more distinctly zerophytic chaparral character. The following collection of woody species, growing on a steep, westerly, limestone slope near Hands' Cabin at approximately 7,000 feet, may serve as a type for calcareous societies of similar situation. The species are ranked in order of abundance: 1. *Ceanothus greggii* A. Gray. 2. *Cercocarpus breviflorus* A. Gray. 3. *Rhus virens* Lindh. 4. *Garrya wrightii* Torr. 5. *Pinus cembroides* Zucc. 6. *Juniperus pachyphlœa* Torr. Below is a society of trees and shrubs typical of a habitat similar to that above in all chief particulars except rock and resultant topography and soil, which is andesitic: *Quercus arizonica* Sarg., *Q. hypoleuca* Engelm., *Q. reticulata* H. B. K., *Pinus chihuahuana* Engelm., *P. mayriana* Sudw., *Ceanothus fendleri* A. Gray, *Gymnosperma corymbosa* DC., *Juniperus pachyphlœa* Torr.

A number of fern species occur upon the limestone, very few upon the andesite, but the latter often supports a better grass cover. *Dasylirion Wheeleri* Wats., though present elsewhere, is highly characteristic of limestone, *Nolina erumpens* Wats. and *Yucca macrocarpa* (Torr.) Coville are seen at their best on non-calcareous soil. The seven species of evergreen oak are almost absolutely absent from pure limestone soil. The only oak (*Quercus pungens* Liebm.) on limestone is not evergreen, and this is never found on other rocks of the region covered.

In a notable recent paper,[14] Fernald brings out similar great contrasts between the alpine floras of northeastern America, and their direct relation to the rock and soil on which they grow. As is abundantly the case in the Chiricahuas, he finds plants that are very definitely limited to certain residual soils on slopes and table-lands, freely commingling on the mixed elements of transported soils at the foot of slopes and along the watercourses.

The ultimate causes of these distributional phenomena, apart from those controlled by altitude and aspect, thus plainly lie in the substratum. How much is due to historic determinants, and how much to physicochem-

[10] The term "formation" is here used only with reference to rock and soil.

[11] In Europe, these definite floral boundaries have long been known to occur, and their immediate cause has been recognized. See Warming, "Pflanzengeog.," sec. ed., p. 78.

[12] MacDougal, *Plant World*, XI., p. 270, 1908.

[13] Not included in above divisions, were also found smaller bodies of volcanic tuff, and still more infrequently, sandstone and shale. For the age of some Chiricahua formations see E. T. Dumble, "Notes on Geology of S.E. Arizona," *Trans. Am. Inst. Min. Eng.*, Feb., 1901.

[14] Cont. Gray Herb., Harv. Univ., N. S., XXXV., 1907.

ical factors at present operative, is not easily established, but observation points strongly toward the latter as controlling forces.

J. C. Blumer

Tucson, Arizona

DIKES IN THE HAMILTON SHALE NEAR CLINTONVILLE, ONONDAGA COUNTY, NEW YORK

The presence of a few igneous intrusions in the almost undisturbed Paleozoic strata of central New York has long been known to geologists. Their extreme rarity, however, has always invested them with a peculiar interest.

Excluding the Manheim Dike near Little Falls, which lies about seventy-five miles east of Syracuse and which cuts Ordovician strata, we find that these igneous rocks may be grouped geographically into (1) those occurring in the vicinity of Ithaca and Ludlowville and (2) those occurring in the vicinity of Syracuse. In both regions the intrusions are peridotite and are mostly true dikes cutting in the first case such Upper Devonian formations as the Genesee shale and the Portage and Ithaca shales and sandstones, and in the second case cutting the Salina beds of Silurian age.

As far as the writer has been able to learn, the geologically intermediate Hamilton shale has, until now, yielded no dikes and the recent discovery of two in this formation at a locality about twelve miles southwest of Syracuse and about forty miles northeasterly from Ithaca is believed to be a matter of interest.

The dikes in question are exposed on the south wall of the Clintonville Ravine at a point approximately fifty feet above the level of the Marietta road. The more western is a fine-grained porphyritic rock resembling peridotite. What appear to be serpentine grains, produced by the alteration of olivine, protrude from the weathered surface and have the appearance of small pebbles. Another conspicuous feature is furnished by large scales of a bronzy mica. This dike has a uniform width of from seven to eight inches and is displayed for about twelve feet on the south bank of the ravine. On the north side it is obscured by talus. Its plane is vertical, while its direction is north and south, agreeing in this latter respect with the Ithaca dikes. Wherever examined it presents a very uniform texture, is apparently free from fragments of the sedimentary rocks through which it passed, and has produced little contact metamorphism.

The second dike discovered by the writer lies about two feet and four inches to the east of the first and was not observed until the wall at this point had been cleaned. It has a width of about eight inches. Like the first dike, it is vertical and north and south in direction. It differs, however, from the first dike in being much weathered in places and in containing many shale fragments some of which have a long diameter of three inches or more.

Burnett Smith

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GUINEA PIG GRAFT-HYBRIDS

In May, 1907, I published results demonstrating, (1) that iso-engrafted ovaries in fowls subsequently exhibit a reproductive function; and (2) that such resulting offspring give evidence of a "soma" or "foster mother" influence.[1] The same year, Professor Wilhelm Magnus, of the University of Christiania, obtained similar results on a rabbit.[2]

The purpose of this note is to record results obtained on a guinea pig. November 6, 1908, the ovaries of a young guinea pig were removed and in the former site of the right ovary, the left ovary from a sister guinea pig was engrafted. The guinea pig was bred and in the latter part of July or the early part of August, 1909, gave birth to two young.[3] As all the animals were mongrels it is obvious that no conclusion regarding foster mother influence is possible.

In Science,[4] September 3, 1909, Professor Castle reports the birth of two guinea pigs from a spayed white mother carrying en-

[1] Proceedings of the society, *American Journal of Physiology*, Vol. XIX., pp. xvi–xvii, July, 1907.

[2] *Norsk magazin for laegevidenskaben*, No. 9, 1907.

[3] November 12, the operated animal gave premature birth to two more young.

[4] N. S., Vol. XXX., No. 766, pp. 312–313.

grafted ovaries from a black guinea pig and bred to a white male. He states that no evidence of foster mother influence was exhibited. Indeed no such evidence was to be expected, for (1) the markings of such hybrids are not uniform, and (2) the mating was not suitable for bringing out such influence. Had the operated pig been bred to a male of the same strain as the pig from which the engrafted ovary was obtained, then in view of my own results on fowls,[5] and Magnus's results on a rabbit,[6] characteristics in the offspring indicative of such influence might have been obtained.

C. C. Guthrie

Physiological Laboratory,
University of Pittsburgh,
October 9, 1909

[5] *Journal of Experimental Zoology*, Vol. 5, p. 563, June, 1908.

[6] *Loc. cit.*

ASTRONOMICAL AND ASTROPHYSICAL SOCIETY OF AMERICA

The American Astronomical and Astrophysical Society held its tenth annual meeting at the Yerkes Observatory, Williams Bay, Wis., on August 19, 20 and 21. The meeting was remarkable for the large attendance and for the number and character of the papers presented. Besides a number of guests there were present Miss Calvert, Miss Bigelow, Mrs. Fleming, Miss Furness, Miss Leavitt, Miss Young, Messrs. Adams, Aitken, Barnard, Barrett, Brown, Buchanan, Burnham, Cogshall, Comstock, Curtiss, Eichelberger, Fisher, Fox, Flint, Frost, Gaertner, Hamilton, Hammond, Humphreys, Hussey, Jordan, Laves, Lee, MacMillan, Mellish, Morehouse, Moulton, Parkhurst, Payne, Peters, E. C. Pickering, Petitdidier, Petrajkis, Plaskett, J. Poor, Roe, Schlesinger, Slocum, Stebbins, Stetson, St. John, Stone, Thaw, Updegraff, D. T. Wilson and H. C. Wilson.

President Pickering, after welcoming the society to Williams Bay, referred to the loss during the last year of two of its oldest members. He said in part: "Professor Newcomb, president of our society for six years, always took the greatest interest in its growth and welfare. It rarely happens that a man is really distinguished in more than one department of science. We all know his preeminence in astronomy. He used to say, 'I am not a mathematician,' yet the Mathematical Society in the strongest terms proclaimed him as their most eminent member. Our attitude should not be that of grief at his loss, but rather rejoicing that he enjoyed many years of usefulness after the age when most men's work is done; he lived to see the great works he had undertaken completed, and he is now saved from the suffering which at the end rendered life a burden to him.

"Professor Hough's activity in science extended over many years. We remember, even at our last meeting, his interest in our work and plans. His observations with the Evanston telescope, at one time the largest in the world, were maintained for nearly thirty years."

The president then discussed the present needs of astronomy and expressed the hope that the society might take active part in supplying them. One of the greatest needs is a number of small grants, not exceeding a thousand dollars each, which could be used with the sole object of securing the greatest scientific return. If made to the larger observatories, careful organization and system would permit a large amount of routine work to be secured. If made to a small observatory, or to an amateur, the skill and experience of an expert in his own specialty might be secured, with results far beyond those which could be obtained by another astronomer, however skilful in other lines of work. The only way to supply such needs is to make them known. President Pickering invited the members of the society to send him examples of such researches. For instance: Professor Bailey is now studying the climate of South Africa, perhaps the best in the world for an astronomical observatory, and will return shortly. He is making visual and photometric observations with a ten-inch telescope, and photographing the Milky Way with a Cook anastigmat, using long exposures. A grant of one thousand dollars would permit this work to be continued for another year by his assistant, thus doubling the results obtained, at a small additional expense.

After the address by the president the following papers were read:

Some Results with a Selenium Photometer: Joel Stebbins.

This paper is a report of progress in the method of using selenium for the electrical measurement of starlight. It has been found that the best results are obtained by keeping the selenium at a constant low temperature in an ice pack. During the past summer, the accuracy of the method has been so increased that it is now possible to measure first-magnitude stars with a probable error of less than 0.01 magnitude.

Precautions Necessary in Photographic Photometry: J. A. Parkhurst.

The results of experiments with stellar and laboratory plates, both focal and extra-focal, were shown by curves thrown on the screen; and the possible errors in stellar magnitude arising from each source were indicated. (1) Comparison of developers, gradation very different. (2) Time of development, possible error exceeding one magnitude. (3) Temperature of development, error nearly one magnitude for range of ten degrees Fahrenheit. (4) Effect of sky fog, possible error of half a magnitude for fog of 0.03 of a density unit. (5) Temperature of exposure, difference of 0.1 magnitude for plates at + 17° and — 2° C. (6) Reduction formulæ for disk diameters of focal images. Error of half a magnitude possible if *log* diameter were used in the formula instead of square root of diameter. (7) Atmospheric absorption. Difference of 0.17 magnitude between the visual and photographic absorptions at 60° zenith distance. (8) Curvature of commercial plates. Error negligible for focal images but might amount to half a magnitude for extra-focal images. (9) Corrections for distance from axis for plates taken 7 mm. from the focus of the Zeiss doublet, amounts to 0.33 magnitude at 3° from the axis. (10) Correction for distance from axis of focal plates might differ by 0.8 magnitude between summer and winter temperatures. (11) Correction for color of stars of solar type is one magnitude. (Details of the work will be published in the *Astrophysical Journal.*)

Standard Photographic Magnitudes: Henrietta S. Leavitt.

Observations for the purpose of determining the absolute photographic magnitudes of a sequence of forty-seven stars near the North Pole have recently been in progress, as described in Harvard College Observatory Circular 150. Sequences of forty stars in the Pleiades and twenty-six stars in *Præsepe* have also been measured, and the results compared with those obtained for the polar stars.

About one hundred and fifty plates were used, taken with eight telescopes. Several methods were employed for determining absolute magnitudes, independent of the visual scale, but all may be grouped in the three following classes:

1. Photographs were taken, diminishing the light by means of screens, or by reducing the aperture of the telescope, and superposing a second exposure of the same length with full light. A similar effect was obtained by attaching an auxiliary prism of very small angle to the object glass; this deflected a part of the light, forming secondary images of the brighter stars.

2. The light was divided by interposing two thin plates of Iceland spar. The positions of the four images of each star furnished the means of determining the relative amount of light in each image.

3. Photographs were taken, having several exposures on the Pole Star, and on the star to be observed, the images being out of focus by varying amounts.

The results obtained by these radically different methods are accordant with each other in the great majority of cases. They also agree closely with the Harvard photometric scale as far as the magnitude 13.2, after allowing for difference of color. We apparently have a satisfactory working basis for determining the magnitudes of stars in all parts of the sky, on an approximately correct scale.

In the discussion that followed Mr. Stebbins's and Miss Leavitt's papers, Messrs. Parkhurst and Humphreys called attention to the large error which might sometimes be incurred by assuming that the absorption of our atmosphere is the same in different azimuths. Professor Pickering remarked that it was the practise to guard against this source of error at Harvard by establishing an arbitrary limit for the residuals obtained with the meridian photometer and similar instruments, and rejecting all observations in which this limit was exceeded.

A Variable Star whose Light Curve Resembles that of R Coronæ Borealis: Annie J. Cannon.

This star, like R *Coronæ Borealis* and RY *Sagittarii*, has long periods of normal brightness followed by sudden fluctuations of large range at irregular intervals. Its position for 1900 is R. A., $5^h 43^m 12^s$; Decl., + 19° 02′.0. It follows the Durchmusterung star + 19° 1081 about 3^s and is south 0′.2.

The Pivots of the Nine-inch Transit Circle of the U. S. Naval Observatory: F. B. Littell.

This paper, which was read by Professor Eichelberger in the author's absence, gave the results of several determinations of these errors. The investigation is valuable not only for its application to the work with this instrument, but is of general interest on account of the experience with various methods for determining inequalities of pivots.

The Algol System, Z Draconis: R. S. Dugan.

The material for this paper consists in 18,384 settings made with the Pickering sliding prism

polarizing photometer, attached to the 23-inch equatorial. Considerably more than half the settings were read and recorded by an assistant. Eleven minima were observed in whole or in part. These minima, together with those observed and published in detail by Graff, gave a graphical determination of new elements. The star at its faintest phase was seldom more than just visible. Under these conditions there was no evidence of variability in the depth of minimum. The mean curve shows a nearly symmetrical primary minimum consisting in a drop of 2.55 magnitudes, and also a secondary minimum of 0.065 magnitudes. Each lasts about six hours. After recovering from primary minimum, the curve keeps on rising slowly for some time, and the beginning and ending of secondary minimum are at a higher level than those of primary minimum. This would indicate ellipticity and reflection. The average surface intensity of one star is 18 times that of the other, and the radius of the fainter lies between 0.98 and 1.86 times that of the brighter. The radius of the orbit is from 3.5 to 5 times the radius of the brighter star.

The Problem of Three Bodies from the Standpoint of Spectroscopy: KURT LAVES.

With the present accuracy in the determinations of velocities in the line of sight the problem of three bodies begins to assume importance in this department of astronomy. The paper dealt with that phase of the subject that is analogous to the lunar problem. The perturbation by the "sun" is broken up into three components, P, T, S, along the radius vector, perpendicular to it and perpendicular to the plane of the orbit, respectively. Calling z' the velocity in the line of sight of the disturbed body, we have $dz'/dt = -P \sin \theta + T \cos \theta$ in which θ is the longitude from the ascending node. P and T may be expressed as functions of θ and when t is also expressed in terms of the same quantity we obtain an equation of the form $z' = F(\theta)$. A comparison with the observed velocity curve leads to a determination of the inequalities involved. The approximation has been carried as far as the second power of the parameter involved.

The Determination of the Moon's Theoretical Spectroscopic Velocity: KURT LAVES.

It was shown that the four quantities V_1, V_2, V_3, V_4, in Campbell's notation, can be calculated by means of tables computed on the basis of the elliptic polar coordinates of the earth and the moon.

$$(1) \qquad V = K \cdot e \cdot \sin \theta$$

will give both V_1 and V_2. V_1 can not exceed 0.50 km. per second, and V_2 is always less than 0.04 km. As the diurnal change in V_1 and V_2 is at most 0.012 km. we may use approximate values of the longitudes of the sun and the moon.

$$(2) \quad V_3 + V_4 = V_2 \cos E + K_2(1 + e_2 \cos \theta_2) \sin E \cos \beta_2;$$

this formula is easily proved with the aid of the hodographic circle. The index 2 refers to the moon. For $K_2(1 + e_2 \cos \theta_2)$ tables may be constructed with the argument θ_2, the true anomaly of the moon. The angle E, which is nearly the difference between the longitudes of the sun and the moon, is computed thus:

$$(3) \quad \tan p_2 = \tan \beta_2 \operatorname{cosec} (\lambda_2 - \lambda) \text{ and } \sin E = \sin \beta_2 \operatorname{cosec} p_2.$$

Tables based on (3) are being computed for various values of β_2. They will be applicable to the planets as well. As the "Nautical Almanac" is planning to discontinue the computation of E the tables here described should be of considerable value to the astrophysicist.

The Effect of Faulty Collimation of the Correcting Lens on the Star Image: J. S. PLASKETT.

The field of the correcting lens used with visual objectives for photographing star spectra is very limited. A slight displacement from the axis disperses the star image, causes a perceptible difference, transversely, in the position of the images due to light of different wave-lengths. It was shown that even the flexure of the telescope is sufficient to produce this effect. The importance of correct adjustment and of compensating for flexure in the effect on exposure time and on the accuracy of radial velocity measurements was pointed out.

The Width of Slit giving Maximum Accuracy: J. S. PLASKETT.

This paper was a continuation and conclusion of one with a similar title presented at the last meeting. It gave results for other instruments of the relative errors of measurement of early type spectra at various slit widths. It was shown that more accordant and accurate values are obtained at a width of about 0.05 mm. than at either narrower or wider slits. Consequently considerable saving of exposure time over that usually given is possible. The bearing of these results on the proportions of the optical parts in spectrographs was also discussed.

The Photographic Doublet of the Dominion Observatory: R. M. MOTHERWELL.

The images produced by the Brashear 8-inch doublet were surrounded by a halo and a series of tests by the Hartmann method showed this to be due to spherical aberration. On the lens being refigured, by the kindness of the Brashear Company, the halo disappeared and it now gives small and sharply defined images with a widely extended field. Diagrams were shown of the aberration at the normal separation of the front elements, at increased separations, as well as after refiguring.

On the Photographs of Comet c 1908 (Morehouse): E. E. BARNARD.

About 350 photographs of this comet were obtained with the three lenses of the Bruce telescope of the Yerkes Observatory. These pictures cover essentially all the more remarkable phenomena of the comet during its visibility in these latitudes, including the extraordinary outbursts or changes that occurred on September 30 and October 15, 1908. The last photograph was obtained here on December 13, 1908, when the comet was close to the horizon. The photograph of December 11 was one of the most remarkable of the entire set. The paper also deals briefly with the possible cause of these extraordinary changes in the tail of the comet.

On Some Experiments in Photographing Enlarged Images of the Planets, direct with the Forty-inch Telescope: E. E. BARNARD.

Experiments have recently been made, with improved facilities, in photographing directly enlarged images of the planets with the 40-inch telescope. Some of the photographs of Jupiter which show the belts well, stand a subsequent enlargement of upwards of two or three inches. Better results are hoped for by the use of a new screen by Mr. Wallace. The results so far show that it is now mainly a matter of favorable definition to secure valuable photographs.

On the Proper Motion of some of the Small Stars in the Dense Cluster M 92 Herculis: E. E. BARNARD.

The visual and photographic measures of the great star clusters show that but little motion exists in any of the small stars composing them. In M 92 *Herculis* motion is shown in several of the smaller stars, amounting in two cases to as much as 5″ a century. These two stars are of magnitude 13.3 and 14. Motion also seems certain in at least three other stars of between magnitude 14 and 15. The next fifty years ought to give us some idea of the relative motion of many of the stars in this cluster. These motions have been brought to light, in this cluster, perhaps because a closer investigation has been made for that purpose than in the case of other clusters.

Lack of Spectroscopic Evidence of a Dispersion of Light in Space: EDWIN B. FROST.

Examination of plates of spectroscopic binaries, taken with the Bruce spectrograph of the Yerkes Observatory, does not give evidence of a difference of radial velocity for different wave-lengths. The star *β Cephei*, having a period of $4^h\,34^m$, would appear especially suitable in this connection. A large range of wave-lengths is obtained for this star only on one-prism plates, and on these any such effect would probably be masked by the accidental errors of measurement. Statistics were read for the star *μ Orionis*, which has a short period, 0.77 day. The spectrum has sharp lines, and many plates have been obtained with three prisms. These show no systematic difference of velocity at different wave-lengths. Mention was made of work successfully commenced with one prism in the red end of the spectrum. While intended for a different purpose, these plates would be available also for a wider range of wave-length in this connection.

Vertical Temperature Gradients in the Atmosphere as Determined by Season and by Types of Weather: W. J. HUMPHREYS.

A large number of sounding-balloon records were grouped according to season and height of the barometer. The results show that while the difference between summer and winter temperatures is most pronounced at the surface of the earth, it is still decided—about half as great—at the highest elevations thus far reached, and that this difference remains essentially constant above an elevation of about ten kilometers, or in the isothermal region. The seasonal effect therefore extends presumably through the entire atmosphere. On grouping into separate curves the summer gradients obtained during high and low barometric conditions, respectively, it is seen that the high barometer, or clear weather conditions, insure higher temperatures than does the low barometer at the surface of the earth and up to near the isothermal region where the conditions are just the reverse; that is, colder in clear than in cloudy weather. Barometer changes have the same effect on the temperature gradients both winter and summer, except at the surface of the earth. Here the temperature is the lowest in winter during clear weather, or high barometer,

and highest under the same conditions during summer. The low barometer gives exactly opposite results. All these phenomena can be explained as the results of radiation and absorption, especially as modified by condensation and varying amounts of water vapor in the atmosphere.

A Proposed Method of Studying Solar Radiation at Great Altitudes: W. J. HUMPHREYS.

The fact that the solar spectrum is limited to wave-lengths greater than 2,900 Ångström units, makes it desirable to determine whether this limitation is due to atmospheric or to solar absorption. High mountain observations have not definitely settled the question and therefore observations at much greater elevations would be desirable. It is proposed to send small automatic spectrographs to great altitudes with sounding balloons. A suitable spectrograph for this purpose was described with a method for securing proper illumination of the slit and exposure at any predetermined altitude.

Planetary Magnetism of the Sun: W. J. HUMPHREYS.

Assuming an ionization and electric separation in the sun's atmosphere sufficient to account for the magnetic condition that Hale has found in the spots, and assuming unit magnetic permeability, or that which obtains for all known substances at high temperatures, it is easy to compute the magnetic field of the rotating sun as a whole. This would be sufficient to produce a magnetic separation, in the case of the more sensitive lines of only about one one-thousandth of an Ångström unit, an amount too small for certain detection. An absence of measurable polar effects must therefore not be taken to be in conflict with the cyclonic theory of the origin of magnetism in the spots.

New Plans for Tabulating the Moon's Longitude: E. W. BROWN.

These plans having already been put into more or less definite shape, the paper contained an account of those parts of them which presented unusual features. The main difficulty consists in tabulating the very numerous small terms chiefly due to planetary action. The great majority of these can by special devices be put into tables. It is hoped that a machine which has just passed through the experimental stage will enable the computer to obtain the sum of the other small terms with great rapidity for half-daily intervals. An outline was given of the general principles that were used as guides for forming tables, the interests of the ephemeris computer being placed before those of the single place computer whenever they were at variance. A detailed account of the methods will be published within a few months.

A Proposed Design for an Objective Prism Spectrograph for the Determination of Radial Velocities: FRANK SCHLESINGER.

It is proposed to employ two photographic doublets of say six inches aperture and of nearly equal focal lengths. Before each is to be placed a prism of the same aperture, the refracting edge of the one being turned toward the north and of the other toward the south. Plate glass is to be employed for the sensitive plates and one of them is to be turned with the glass side toward the objective. One of the objections to the use of an objective prism in quantitative work is the effect of changes of temperature upon the dispersion of the prisms. It is proposed to obviate this difficulty by surrounding the entire spectrograph with a temperature case supplied with an automatic temperature control, the light from the stars being admitted to the objectives by means of two sheets of plane-parallel glass. The plates are to be measured by superimposing them and obtaining the distance between corresponding lines in the two spectra of each star. These distances will be affected by the radial velocity and will therefore enable us to compute the latter. After an investigation into the various distortions that the spectrograph would involve, and of the sources of error to which the measures would be liable, it was concluded that such a spectrograph would be able to determine the radial velocities of faint stars with a probable error not exceeding ten kilometers for each pair of plates.

Improvements in the Observatory at Ann Arbor: W. J. HUSSEY.

These consist in the overhauling of the director's residence and the installation of instrument shops, a new 37-inch reflector, a single-prism spectrograph and a seismograph.

On Differential Flexure in the Single-prism Spectrograph: R. H. CURTISS.

After calling attention to the serious effect that flexure might exercise in this form of spectrograph, Dr. Curtiss described the device adopted to eliminate it at the Detroit Observatory. As in the case of the Southern Mills three-prism spectrograph and the Mellon single-prism spectrograph of the Allegheny Observatory, the spectrograph box is supported at two points so placed as to make the flexure a minimum. With the Detroit spectrograph Dr. Curtiss has introduced the fur-

ther improvement of making one of these supports adjustable and determining its best position by actual experiment.

The Focal Curves of the Single-material Camera Doublet of the Single-prism Spectrograph of the Detroit Observatory: R. H. Curtiss.

This paper dealt with a recent investigation of the focal curves from λ 3900 to λ 6000 of the new camera lens mentioned in the title. The collimator is an Isokumat of 27.5 inches focus and 1.4 inches aperture. The camera lens has a focus of 16 inches. Nine different combinations of collimator and prism settings were tried covering all cases that might be advantageous. It was found that the deviation from straightness of the focal curves was practically the same in all cases over a distance of 34 mm. But for the portion of the curve corresponding to the interval λ 4000 to λ 5900 the deviations were least for minimum deviation settings in the neighborhood of λ 4400. It was found that the entire region from λ 3900 to λ 6000 could be photographed in sharp focus upon one negative.

The New Spectrograph Measuring Engine of the Detroit Observatory: R. H. Curtiss.

This engine was constructed from designs by Dr. Curtiss based upon his experience with instruments of the Zeiss, Toepfer and Gaertner types as well as with one made by the John A. Brashear Company for the Allegheny Observatory after designs by Professor Schlesinger. The principal features are: a sector for inclining the engine at any desired angle; a long clock spring for taking up the back-lash of the screw; a reversible secondary plate carriage; a motion of rotation of the microscope around an axis parallel to the screw; the use of an interrupted reticle and a removable reticle holder to carry glass reticles of any type. The screw of the engine was made at the observatory shop and seems to possess a remarkable accuracy.

Solar Spectroscopic Observations: Philip Fox.

Results in three lines of work were presented: (1) Spectrograms of a dark calcium flocculus that had a high velocity. (2) A brief report on the work undertaken by Dr. Abetti and the author on the sun-spot spectrum. The photographs were obtained with an 18-foot Littrow spectrograph used with an horizontal telescope of 60 feet focal length. The investigation covers the region from λ 3900 to λ 6800 and includes about 8,000 altered lines. (3) A preliminary report concerning a comparative study of the spectra of the details of the photospheric granulation.

The Use of Quartz Fibers for Micrometer Wires: Philip Fox.

Spider-threads, while excellent in many ways, have two disadvantages: they are affected by humidity and they are too coarse. It is a difficult matter to find spider threads whose diameters do not exceed the resolving power of the telescope. The author has made some experiments with quartz fibers furnished by Professor Nichols. There was no difficulty in finding and mounting fibers that were one third of the usual diameter of spider threads. They are very smooth and do not readily retain dust particles, they are easily illuminated and are not affected by changes in humidity. One fiber has been in use for more than a year.

In the discussion that followed this paper attention was called to the fact that owing to the non-elastic qualities of the fiber there was a tendency for it to work loose from the mounting, under the temperature conditions that usually prevail at a telescope.

Some Dynamical Considerations on Globular Star Clusters: F. R. Moulton.

The assumption on which this paper was based is that the dimensions, masses and relative velocities in the globular star clusters are such that they maintain essentially constant dimensions. Consequently, if this assumption is sound, when two of the three classes of data are furnished by observations, the third, *e. g.*, the masses, is given by the equational relation which is developed.

If π is the parallax of the cluster, D the diameter of the cluster in the same units, N the number of stars in it, then ρ, the average distance between adjacent stars, is

$$\rho = \frac{D}{\sqrt[3]{N}\pi}.$$

If $N = 5{,}000$, $D = 30'$, $\pi = 0''.01$, which is the mean parallax of fifth magnitude stars according to Kapteyn's formula, we have $\rho = 10{,}500$ astronomical units.

An important question in the discussion is whether a star passing through the cluster has many close approaches to other stars, and whether it may be prevented from leaving the cluster by the general gravitative control of the whole group of stars. If R is the radius of the cluster in astronomical units, the probability, P, that a star passing through the cluster will pass within r astronomical units of at least one other star is

$$P = \frac{3}{2}\left(\frac{r}{R}\right)^2 N.$$

With $r = 10$ and the data assumed above, we have $P = 1/43{,}000$. Hence near approaches in such a system are extremely rare.

The period of revolution of a star in a star cluster of approximately homogeneous star distribution, is

$$T = \frac{2\pi R^3}{k\sqrt{M}},$$

where M is the total mass. Supposing $M = 5{,}000$ times the sun's mass and the other data as above, we find $T = 89 \times 10^{12}$ years.

The greatest velocity is

$$V = \frac{k\sqrt{M}}{\sqrt{R}}$$

at the center of the cluster. With the data used above, $V = 1.04$ astronomical units per year; or, in angular measure, as a maximum, 0".01 per year. The apparent angular velocity varies with the three-halves power of the parallax. Consequently if the large value taken above is actually ten times too great, the greatest apparent angular velocity is only 0".0003 per year. If these numerical assumptions be regarded as reasonable, then sensible relative motions of permanent members of star clusters are not to be expected until the observations extend over some decades.

Achromatic and Apochromatic Comparative Tests—Second Communication: E. D. ROE, JR.

This paper presented the final results of the testing of two objectives, which was outlined a year ago in a preliminary communication before the society. The two objectives, two-lens type achromatic and apochromatic telescope objectives of approximately the same aperture and focal length, by Mr. Lundin and Steinheil Söhne, respectively, were tested visually on double stars, and in the laboratory the photographic knife edge test was applied to both objectives with satisfactory results, while the color curves of the two lenses were ascertained by measurements on extra- and intra-focal spectrograms. The paper will appear in *Archiv für Optik* (Berlin).

Report of Progress on the Radial Velocity Program of the Lick Observatory: W. W. CAMPBELL.

The programs of observation for the Mills spectrograph attached to the 36-inch equatorial, and for the D. O. Mills expedition to the southern hemisphere (Santiago, Chile) have aimed to secure at least four spectrograms of every star down to the 5.0 visual magnitude, with 3-prism dispersion if possible, and of somewhat fainter stars, especially in the southern hemisphere, with 2-prism dispersion. Up to June 1, 1909, 3-prism spectrograms of 882 stars had been obtained at Mt. Hamilton; 200 of these, whose spectra contain broad and poorly defined lines, have been rejected from the main program for observation later with lower dispersion. Excepting these, the northern observing program is essentially complete for the good summer months; and if next winter, and especially next spring, have average weather conditions, the program should be nearly complete throughout the twenty-four hours of right ascension, by June 1, 1910. The D. O. Mills expeditions, under Astronomers Wright and Curtis, successively, have observed altogether 530 stars brighter than 5.01 visual magnitude and about 150 stars fainter than 5.00 magnitude, or 680 stars in all. Correcting for those stars observed at both Mt. Hamilton and Santiago, the total number of stars whose spectra have been photographed is 1,368. The original Mills spectrograph was succeeded in May, 1903, by a new Mills spectrograph. All the spectrograms obtained with the original spectrograph, and about three fourths of those obtained with the new spectrograph, have been measured and reduced definitively, and are being rapidly prepared for publication. During the first period of the D. O. Mills expedition, in charge of Astronomer Wright, covering two years of observation, spectrograms of about 200 stars were secured. Those containing lines suitable for accurate measurement numbered 148, and four plates, on the average, were obtained for each of these. The results, including all the text, are entirely ready for publication in volume form. Of these 148 stars, 29, or one in five, have been found to have variable velocities. Of the plates secured during the second period of the D. O. Mills expedition, under Astronomer Curtis, about one third have been measured and reduced definitively by Dr. Curtis and his assistant, Mr. Paddock, while carrying on the work of observing. The remainder have been measured approximately—that is, utilizing only a few of the available lines. It should be said that only a small proportion of the spectroscopic binaries discovered at Mount Hamilton and in Chile have been investigated. To do this would require several years of observing, measurement and computation.

The Lick Observatory Double-star Survey—A Report of Progress: R. G. AITKEN.

The program for this survey as originally planned contemplated the examination of every

star to the magnitude 9.0 in the Bonn Durchmusterung from the north pole to declination 22° south, with the object of securing data for a statistical study of double stars. Since 1905, when Professor Hussey left the observatory, the work has been carried on by the author alone. It should be completed in two years' time, provided that the observing conditions between December and June are reasonably good. At present about 85 per cent. of the area has been examined; 3,375 close double stars have been added to those previously known and of these 1,327 are to Professor Hussey's credit. One star in eighteen of those examined has proved to be a double with a separation under 5″. It appears that double stars with a separation under 2″ are far more numerous than those between 2″ and 5″. The discussion of the material thus far collected is under way, but definitive results will not be forthcoming until the survey has been extended to the south pole. It is hoped that an expedition suitably equipped to carry out this program may be sent to South America by the Lick Observatory immediately upon the conclusion of the present survey.

Spectrographic and Photographic Observations of Comet c 1908 (Morehouse): HEBER D. CURTIS.

Between the dates February 23 and March 23, 1909, one slit spectrogram and seventeen objective-prism spectrograms were secured at the observatory of the D. O. Mills expedition. With the slit spectrograph it was found possible to obtain only the strongest of the pairs of lines of unknown origin which characterized this comet. The wave-lengths of this pair as derived from the slit spectrogram are λ 4254.2 and λ 4275.4.

The following are the wave-lengths as derived from the objective-prism plates: λ 3914.1, λ 4002.1, λ 4021.3, λ 4254.0, (λ 4276.0), λ 4526.0 ±, λ 4545.9, λ 4570.2, λ 4690.7, λ 4716.3. Collecting the differences for the three strongest pairs of lines, λ 4002–21, λ 4254–76, λ 4546–70, together with the corresponding angles at the comet between the radius vector and the line connecting the comet with the earth, we have:

Observer	Date	$\Delta\lambda_1$	$\Delta\lambda_2$	$\Delta\lambda_3$	Angle
Deslandres and Bernard	1908 Oct. 14	20	23	20 ±	39°.9
Deslandres and Bosler	Nov. 1	19.7	21.6	22.0	46.3
Campbell and Albrecht	Nov. 28	19.6	20.7	20.8	37.2
Curtis	1909 Feb. 25	18.5	22.0	24.5	39.7
Curtis	Mar. 21	19.4	22.5	23.8	35.6

The objections to interpreting the doubling of these lines as a Doppler-Fizeau effect have already been stated by Campbell and Albrecht (cf. Lick Observatory Bulletin, No. 147). Assuming the actual velocities along the tail or transverse to the tail to have been the same when Deslandres and Bosler observed on November 1 and when the author observed on March 21, the mean of the intervals for the three principal pairs of lines should have been about four tenth-meters greater, or less, respectively, on March 21 than on November 1, whereas the observed intervals were not quite one tenth-meter greater on the latter date.

The various spectral images are replicas of the tail, as shown by the direct photographs taken at the same dates, as far as can be made out on the small scale of the plates. In this respect the plate of March 20 is of especial interest. The direct photograph on this night shows a marked curve in the tail about half a degree from the head, a curve which is duplicated in each of the spectral images.

Twenty-eight direct photographs of the comet were also made during this period, the majority of them with a 6½ inch portrait lens; many of these plates show interesting evidences of the extraordinary activity which characterized this comet both before and after perihelion.

Three Stars of Great Radial Velocity: HEBER D. CURTIS.

A number of stars with proper motions of 1″.0 per year or greater have been investigated with the spectrographs of the D. O. Mills expedition to the southern hemisphere, and in the course of this work three stars have been found with radial velocities of unusual magnitude. Of these the most interesting is the star Cordoba Zones 5h243 ($\alpha = 5^h\ 7^m.4$, $\delta = -44°\ 56'$) whose proper motion of 8.7 seconds of arc per year is the greatest thus far observed. Its magnitude is 9.2, and its photographic magnitude about 10.5, so that a satisfactory plate was secured only by prolonging the exposure time to twenty-nine hours on four consecutive nights. The mean of two plates shows that the star is receding from the sun at a rate of 242 km. per second. Using the Cape value of the parallax of this star, 0″.312, with Kapteyn's values for the proper motion in right ascension and declination, and eliminating the motion of the solar system in accordance with Campbell's value, the resulting space velocity of this star is about 261 km. per second, directed toward a point whose coordinates are $\alpha = 122°$, $\delta = -60°$. This enormous space velocity seems to be exceeded only by the star 1830 Groombridge, which is traveling at a rate of about 278 km. per second toward an apex in $\alpha = 250°$, $\delta = -52°$. From five plates

a velocity of recession of 100 km. per second was found for the star Lacaille 2957, and a velocity of approach of 132 km. per second in the case of the star Lacaille 8362, derived from three plates.

Thirteen Stars having Variable Radial Velocities: HEBER D. CURTIS.

This paper gave a list of thirteen new spectroscopic binaries discovered during the past two years in the course of the work of the D. O. Mills expedition to the southern hemisphere. Eight of the number were discovered by Dr. Curtis, and five by Mr. George F. Paddock. In two cases the spectra of both components of the system are visible.

Note on the Apparent Wave-lengths of Lines in the Different Spectral Types and in Certain Variable Stars: SEBASTIAN ALBRECHT.

In 1906 the author made an investigation of the individual spectrum lines in certain spectrograms, with a view of determining whether there is a shift of any of the lines which is progressive from spectral type to type. A preliminary list of lines which undergo such a change, as indicated by the radial velocities obtained from them, was published in November, 1906. This investigation has been continued intermittently during the last two years, and a number of additional lines have been found whose positions also change progressively.

In the paper referred to, a comparison was made with Mr. Adams's list of sunspot lines (*Aph. Jour.*, 24, 1906). The principal result of the comparison was the strong indication that the physical conditions in the stars as we pass from the F to the Mb type vary roughly in the same direction as from the sun to the sunspots. The results for the additional lines are in harmony with the above conclusion.

In his first paper the author expressed the opinion that for variable stars of large light changes similar changes of apparent wave-lengths of line might be found, corresponding to changes in spectral type from maximum to minimum. Measures of the available spectrograms of the fourth class variables η *Aquilæ* and l *Carinæ* were tabulated according to phase of light variation and some lines in the case of each star were found to show a variation dependent upon the phase of the light curve. In general, the direction of variation is such as to indicate a later spectral type at minimum than at maximum, though the variation does not in each case take place in the same part of the light curve. The change in the spectrum of the variable star is probably such that the spectrum always has some characteristics of more than one spectral type.

Unpublished Work of the Harvard Observatory: EDWARD C. PICKERING.

Discussion of the Revised Harvard Photometry, *H. A.*, 64, 4, pp. 56; ready for distribution.

Observations on J. D. 3182 with the Four-inch Meridian Photometer, *H. A.*, 64, 5, pp. 12; ready for printing.

Magnitudes of Components of Double Stars, *H. A.*, 64, 6, pp. 34; in type.

A Discussion of the Eclipses of Jupiter's Satellites, 1878–1903, by Ralph A. Sampson, *H. A.*, 52, 2, pp. 190; in type.

Durchmusterung Zones Observed with 12-inch Meridian Photometer, 190 pages; in type.

Maxima and Minima of Variable Stars of Long Period, 130 pages; in type.

Photometric Measurements made with the East Equatorial, by Oliver C. Wendell, pp. 56; in type.

Photographic Magnitudes of Seventy-two Bright Stars, Photographic Observations of Occultations, Eclipses of Jupiter's Satellites, Transformation of Prismatic to Normal Spectra, Miscellaneous, by Edward S. King; nearly ready for printing.

Statistical Investigations of Planetary Orbits, by W. H. Pickering; nearly ready for printing.

The Zone of Stars, in declination —9° 50′ to —14° 10′, observed by Professor Searle with the eight-inch meridian circle, is now nearly completed. It will occupy three volumes of the *Harvard Annals*. It will be sent to the printer this autumn, unless unforeseen delays arise.

The Photographic Search for Planet O: W. H. PICKERING.

The search for this planet was prosecuted on plates taken by the Rev. Joel H. Metcalf with his 12-inch doublet. Two plates of each region were taken at intervals of a few days apart. A positive was printed from one of these, and the other negative superposed upon it. It was expected to detect the planet by its motion during the interval elapsed. The planet has not as yet been found. This may be due to one or more of three causes: (*a*) The planet may be unexpectedly faint, or reddish in color. Its computed magnitude is 13.5. (*b*) The orbit may be highly eccentric, the computation being based on an approximately circular orbit. (*c*) The orbit may be highly inclined to the ecliptic, and the planet at present situated far from its node. For various reasons the first two causes are not thought sufficiently effective to interfere with the discovery of the planet. We might, by analogy, compare planet *O* on account

of its relative size and position with regard to the other planets, to the sixth or seventh satellite of Jupiter. The inclinations of the orbits of these two bodies are 28° and 26°, respectively. The region already covered in the photographic search extends along the ecliptic for 25°, and reaches to a maximum distance of 10° to the north and south of it. It is expected therefore to make an examination of the higher latitudes next year. The number of stars already examined in the search is estimated at about 300,000.

The Spectrum of a Meteor: WILLIAMINA P. FLEMING.

On August 14, 1909, while examining a shipment of plates recently received from Arequipa the spectrum of a meteor was found on a photograph taken with the Bruce 24-inch telescope on May 18, 1909. This must have been an unusually bright object, since its trail is very intense, consisting of twenty-three bright lines or bands. As the photograph has so recently been received at Cambridge no study of the spectrum has as yet been attempted.

Graduation Errors of the Circles of the Six-inch Transit Circle of the U. S. Naval Observatory: J. C. HAMMOND.

This consisted of a description of the methods and results of a thorough examination of the circles that is still in progress. The circles were graduated by the Warner and Swasey Company, of Cleveland, and seem to be quite as accurate as those of the best foreign makers. The examination brought to light a periodic error that repeated itself in every ten minutes of arc. This was traced to a slight eccentricity of a ratchet-wheel and has been corrected for circles subsequently graduated with this engine.

The Clock Vault of the U. S. Naval Observatory: EDGAR TILLYER.

In this paper, which was read by Professor Updegraff in the absence of the author, Mr. Tillyer described the devices adopted for maintaining constant temperature in the vault in which are mounted three Riefler clocks.

On the Construction of Astronomical Photographic Objectives at the U. S. Naval Observatory: GEORGE H. PETERS.

Mr. Peters first described the various attempts that had been made to install a photographic instrument at the observatory with the use of material already at hand, the most noteworthy of these being the reassembling of the parts of the old mounting of the 26-inch equatorial to serve as a mounting for various cameras. Mr. Peters has now undertaken the construction of two 10-inch objectives of about 110-inch focus. These are of the type in which three lenses are employed with large separations. The curves were computed by Mr. Tillyer and the grinding is being done with a machine constructed in the observatory shop.

At the annual meeting of 1908 the society had appointed a committee on luminous meteors. This committee presented a detailed report written by its chairman, Professor Cleveland Abbe, giving a résumé of what had previously been done toward securing photographs of meteor trails. The various methods and instruments that have been employed or proposed were critically examined from the point of view of the astronomer as well as from that of the meteorologist. The report strongly urged the establishment of a network of photographic stations about one hundred miles apart for the purpose of obtaining a tolerably complete record of all the meteors appearing within the network. Automatic instruments of as simple and inexpensive a type as practicable were recommended.

The committee on comets, also appointed at the 1908 meeting, reported orally through its chairman, Professor Comstock. Its attention had been given mainly to the approaching return of Halley's comet. In order that this comet may be adequately observed it will be necessary, on account of its close approach to the sun at the time of maximum brilliancy, to have stations widely distributed in longitude. To secure such stations correspondence has been had with observatories in the eastern hemisphere. The Pacific Ocean presents a wide gap in which no available station exists and the committee has assumed the task of securing funds for the establishment of a temporary station, presumably in the Hawaiian Islands. Such funds are now assured in case the circumstances of the comet's return render it desirable to send out a party. The appearances that the comet will present depend so much upon the exact date of its return to perihelion that no definitive program of observation can be framed before the rediscovery of the comet. It appears, however, advisable to separate the observing program into three classes of observations, viz., photographic, photometric and spectrographic, and the preparation of a detailed program of these divisions has been entrusted, respectively, to Professors Barnard, Pickering and Frost. It is the

purpose of the committee as soon as it has adequate data at its disposal to formulate and publish the proposed program under these several heads.

A proposal to change the name of the society to the American Astronomical Society was discussed at considerable length. It was the feeling of most of the members present that such a change would be desirable from some points of view; as, however, fears were expressed that this change might tend to deprive the society of the great benefits that it now derives from the attendance and contributions of some who engaged altogether in laboratory research, it was voted not to omit the word "Astrophysical" from the name of the society.

A proposal that the society should go on record as deeming any attempt to communicate with Mars as being unpracticable at the present time and as deprecating the use of any funds for such a purpose was also voted down. The members present were unanimous in believing that such attempts are useless, but were of the opinion that it would be wise not to dignify with any formal action the absurd accounts that have recently appeared in the newspapers.

Upon recommendation by the council the society decided to issue a volume giving an account of its activities during the first ten years of its existence. The council announced that thirty-four persons, an unusually large number, had been elected to membership at this meeting; and that the next meeting would be held during August, 1910, at the Harvard College Observatory, the exact date to be determined later.

The last formal action to be taken by the society before its adjournment was the unanimous adoption of the following:

"The Astronomical and Astrophysical Society of America, assembled at its tenth annual session, records its great regret at the death of its first president, Professor Simon Newcomb. Deeply interested in the cooperation and mutual influence of scientific men, Professor Newcomb was conspicuous in the organization and early progress of the society, and was a dominant factor in determining its relation to contemporary astronomy. His enthusiasm for the science and his wide knowledge of its many branches made his presence and participation in the meetings of the society a perennial inspiration to its members.

"Professor Newcomb's own achievements in exact and theoretical astronomy have already become classics in the history of the subject, and will constitute his permanent memorial. The record of a long and active scientific career is closed with the fulfilment of many of his most cherished ideas, and we deeply regret that he was not longer spared for the further development of those subjects to which he had largely contributed.

"The society records its profound respect for the departed member and directs its secretary to transmit a copy of these resolutions to his bereaved family."

FRANK SCHLESINGER,
Editor for the Tenth Annual Meeting

SOCIETIES AND ACADEMIES

THE AMERICAN MATHEMATICAL SOCIETY

THE one hundred and forty-fifth regular meeting of the society was held at Columbia University on Saturday, October 30, 1909, extending through a morning and an afternoon session. About forty persons were in attendance, including twenty-seven members of the society.

Vice-president Edward Kasner occupied the chair, being relieved at the afternoon session by ex-presidents W. F. Osgood and H. S. White. The following persons were elected to membership: Dr. H. T. Burgess, University of Wisconsin; Professor H. H. Dalaker, University of Minnesota; Mr. G. C. Evans, Harvard University; Mr. Louis Gottschall, New York City; Dr. J. V. McKelvey, Cornell University; Miss H. H. MacGregor, Yankton College; Mr. H. H. Mitchell, Princeton University; Mr. U. G. Mitchell, Princeton University; Mr. R. R. Shumway, University of Minnesota; Dr. H. L. Slobin, University of Minnesota; Mr. I. W. Smith, University of North Dakota. Four applications for membership in the society were received. Mr. C. B. Upton, of Teachers College, was appointed assistant librarian of the society.

Resolutions were adopted expressing the sense of loss to the society and to science occasioned by the death of Ex-president Simon Newcomb.

The following papers were read at this meeting:

C. N. Haskins: "On the extremes of functions."

P. A. Lambert: "On the solution of linear differential equations."

Florian Cajori: "Note on the history of the slide rule."

Carl Runge: "A hydrodynamic problem treated graphically."

Edward Kasner: "The motion of particles starting from rest."

G. A. Miller: "Note on the groups generated by two operators whose squares are invariant."

C. N. Moore: "On the uniform convergence of

the developments in Bessel functions of order zero."

The Southwestern Section of the society will meet at the University of Missouri on Saturday, November 27. The winter meeting of the Chicago Section will be held at the University of Chicago on Friday and Saturday, December 31 and January 1. The annual meeting of the society will be held at Boston, in affiliation with the American Association, Tuesday to Thursday, December 28–30.

F. N. COLE,
Secretary

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

THE 669th meeting was held in the West Hall of George Washington University, on October 23, 1909, President Wead in the chair. The following papers were read:

A Mechanical Means for Effecting Certain Conformal Transformations: DR. R. A. HARRIS, of the Coast and Geodetic Survey.

Attention was called to the fact that a mechanism which sums continuously and simultaneously two trigonometrical series, the one consisting of sine terms, the other of cosine terms, may be readily adapted to conformal transformations. The independent variable z is assumed to describe circular paths concentric about the origin in the z-plane, and through interruptions at regular intervals, to indicate the orthogonal paths which are radiating straight lines through the origin. Z will describe a system of curves in the Z-plane corresponding to the circles, while the interruptions in the Z-motion will define a system of orthogonal curves corresponding to the radial lines in the z-plane.

We have in general:

$$\begin{aligned} Z = Az^a + Bz^b + \cdots &= X + iY \\ &= \mathrm{mod}\ Ar^a\ [\cos\ (a\theta + \alpha) + i\ \sin\ (a\theta + \alpha)] \\ &\quad + \mathrm{mod}\ Br^b\ [\cos\ (b\theta + \beta) + i\ \sin\ (b\theta + \beta)] \\ &\quad + \cdots\cdots\cdots \end{aligned}$$

where r denotes the modulus, and θ the argument, of z. The arguments of A, B, $\cdots$ are α, β, $\cdots$. The exponents a, b, $\cdots$ are real numbers and may be positive or negative, integral or fractional. The motion of Z is the resultant of the motions along X and Y. These two rectilinear motions can be produced simultaneously by a mechanism similar to that described by W. H. L. Russell in the *Proceedings of the Royal Society of London*, Vol. 18, 1869.

When only two powers of z are involved in the expression for Z, a very simple instrument can be used in effecting the required transformation; viz., an instrument which continuously combines two circular motions. Such an instrument consists essentially of two graduated arms or cranks, made to revolve with the required angular velocities by means of suitable gears, and a parallelogrammic arrangement so connecting the revolving arms that at each instant the half sum of the two circular motions is indicated by a tracing point.

Attention was called to numerous examples, such as $Z = z + Bz^{-b}$, $Z = z - Bz^b$, where B and b are real positive quantities; $Z = z + 1/z$, $Z = z + z^2$, $Z = z + z/\nu$, etc.

A mechanism capable of performing a considerable variety of transformations like these was exhibited before the society; also a small copper plate upon which several curves had been etched mechanically by means of the instrument.

The International Unit of Light; Photometric Units and Nomenclature: DR. E. B. ROSA, of the Bureau of Standards.

The speaker gave the definitions of seven photometric magnitudes and derived the equations showing the relations between them. These quantities are: (1) the *intensity*, (2) *luminous flux*, (3) *illumination*, (4) *radiation*, (5) *brightness, or specific intensity*, (6) *the surface integral of the latter over the source*, (7) *quantity of light, or the time integral of the flux*. The first three of these quantities are most used in practical photometry and illuminating engineering, but the others are required in a complete system, and it contributes to clear thinking and concise expression to have a separate name for each different quantity. The corresponding names in French and German were given, and some changes in these names suggested that would make the nomenclature in the three languages more nearly uniform.

R. L. FARIS,
Secretary

NEW YORK ACADEMY OF SCIENCES—SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY

A MEETING of this section was held on Monday, October 18, at the American Museum of Natural History. Mr. Edward Thatcher read a paper on "Some Principles in Art Metal Work"; W. Campbell, "On the Structure and Constitution of some Alloys and Metals used in the Arts," and Professor D. W. Hering, on "Wave-length of Light by Newton's Rings."

WM. CAMPBELL,
Secretary

SCIENCE

FRIDAY, DECEMBER 3, 1909

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE DUTY OF THE AGRICULTURAL COLLEGE[1]

A QUARTER of a century ago the sort of education for which the Kansas State Agricultural College stands was in its experimental stage. Its right to a place among the well-directed efforts of our people was seriously questioned.

That in this brief period these agricultural and mechanical colleges should completely break down opposition, allay prejudice and come into a commanding position, was beyond the hope of even their most ardent advocates.

"The influences which were set in motion by the passage of the Morrill Act have already developed a new education."[2] President Schurman, of Cornell University, recently characterized the founding of the land-grant colleges of America, through which universal industrial education was made possible, as the third and perhaps the greatest epoch in the educational history of the world.

The impress of these institutions upon the systems of education has been no less important than that upon the industries themselves. From the very beginning the instruction in the mechanic arts and engineering was successful, and the men engaged in these industries were quickly brought to a realization of this fact and accepted in full confidence the college-made engineer.

[1] Inaugural address of Professor H. J. Waters, on the occasion of his formal installation as president of the Kansas State Agricultural College, Manhattan, Kansas, November 11, 1909.

[2] President W. E. Stone, semi-centennial celebration of Michigan Agricultural College.

While in the public discussions leading to the establishment of these colleges, agriculture received chief attention, yet when they were organized few students applied for instruction in this subject, and for many years little impress was made upon the farm practises of the country. It is, in truth, only within the last decade that a system of instruction and research has been developed and perfected that is shaping the policies and destinies of this, the oldest and most important occupation of man.

It was one of the most fortunate circumstances connected with the creation of these colleges that the act of Congress bringing them into existence was comprehensive enough with respect to their purpose and objects to admit of the teaching of a wide range of subjects. The comprehensive charter with which they were vested permitted of extensive experimentation in courses of study, a wide adaptation in subjects taught, arrangement of courses, methods of instruction, etc. Untrammeled by tradition, they were free to make experiments in the subject matter taught, as well as in the method of teaching it.

Broadly speaking, there has been assigned to this class of colleges, in the natural division of labor, the great industrial problems of our people, including the development and conservation of the material resources of the country, as well as the great economic and sociological questions affecting the industrial classes.

As interesting as the history of the development of these colleges is, and as rich in history as this particular member of the group is, on an occasion like this a glance into the future is perhaps more appropriate, for it is there that our problems lie.

COMPETITION IN EDUCATION

The American ambassador to Great Britain recently facetiously referred to our educational system as America's chief industry. In other ways it is frequently suggested that in this matter the rate of growth has been out of proportion to our development in other directions and beyond our real needs.

Of the eighteen million children in the graded schools in the United States to-day, less than a million, or less than one in twenty, will ever matriculate in a high school or an academy. Moreover, of the nine hundred thousand pupils in the secondary schools, only about two hundred thousand will be enrolled in our colleges and universities, or approximately one out of every four.

It requires, therefore, approximately eighty pupils in the grades to supply one college or university student. Less than one in five of these college and university matriculates graduates. Therefore, over four hundred graded school pupils are required to furnish one college graduate.

Of more significance than all this is the fact that seven out of every eight of the boys and girls of the United States leave school between the fifth and sixth grades and go out into a world of splendid opportunities without the training and intellectual power to enable them to take advantage of these opportunities.

It would not seem, in the light of these facts, that there was much serious competition in education. In fact, it does not appear that we are doing very much to break down human ignorance and overcome human prejudice.

TAKE THE COLLEGE TO THE PEOPLE

While it is of paramount importance that the college give thoroughly sound instruction to the young men and young women in residence, it is equally true that its activity must not end here. More and more must the college be carried to the people. At best but a small proportion of

those who should avail themselves of its advantages can leave home.

Farmers' Institutes.—This phase of the college work, as it affects the farmer, is already well organized and bringing splendid results. Through the farmers' institutes, farmers' conventions, instruction trains, demonstration farms, etc., the whole state is being reached. It is expected that the representatives of the college will this year come into personal touch with fully seventy-five thousand farmers and farmers' wives, or more than one out of every three farmers in Kansas. It is possible that it will soon be found necessary to offer courses in agriculture and home economics of varying lengths in different parts of the state, to accommodate the increasing demand for instruction in these subjects on the part of those who can not leave home.

Outlying Experiments.—It is not sufficient to conduct experiments at Manhattan and Fort Hays and call the problems finally settled in accordance with the teachings of these results. Kansas is a large state, with a great variety of soils, and great variation in rainfall and in plant and animal adaptation. As soon as funds for this purpose can be provided and the work so organized that it may proceed in each case along lines that are fairly certain to yield profitable results, there should be instituted systematic tests or experiments in every county in the state. This will be found profitable not only because of the exact information secured, but by reason of the greater confidence which the farmers will have in the results, because they were secured under conditions which they recognize as identical with their own.

Then, these experimental fields may also serve an exceedingly valuable educational purpose, by being so planned that they demonstrate some point in agricultural practise of especial importance to the community in which they are established.

Farm practise is developing at so rapid a rate and so many methods are being found to succeed well under one set of conditions and not under another, that for the individual farmer to try, at his own expense, all that good judgment indicated might be worth trying, would mean that his farm must become an experiment station instead of a business enterprise. It is, therefore, the business of the state and federal government to put these things to the test for him, and under conditions closely approximating his own.

State Surveys.—For the first time in our history, we have become interested in the conservation of our resources. A young nation, like a young person, is proverbially profligate of its resources. Ours has been a waste of the resources of soil and forest and stream that is without parallel in the history of the world. This waste has been largely due to improper systems of farming, and can not continue another century without bringing ruin to America's basic industry. Under the teachings of institutions like this, larger returns may be secured without depleting the soil than are now secured under a system of land spoliation. This is a matter of concern not only to the landowner, but to the whole of society, since the future welfare of our cities and factories and churches and schools is directly dependent upon the returns from the farm.

We are now in a frame of mind to consider methods of checking this waste. The first step is to take account of stock. The Kansas landowner needs to know what types of soil he has, what amount of plant food each contains, to what each is best adapted, and how it may be managed to yield the largest return without having its productiveness diminished. The college

should at once organize a state soil survey, and push it towards completion as rapidly as the facilities provided by the state and federal government will permit. This is fundamental to all agricultural progress. Later, surveys of special industries or crops should be instituted, to determine upon what types of soil and under what conditions they are succeeding and under what conditions they fail, that it may form the basis of researches to point out the way to make them successful under all conditions.

A corn and forage plant survey, to extend the boundary of successful farming still further westward, is an enterprise in which this state can well afford to engage.

Conserving Water Power.—These efforts should not be limited to agriculture. A series of investigations and experiments looking toward the conservation and utilization of the water supply of the state, for the purposes of both irrigation and power, is a duty which the college owes to the public. There are doubtless many localities in which sufficient power could in this way be developed to supply the needs of farm and village within the radius of twenty or more miles. In many other places hydraulic power could be developed sufficient to furnish light and power for from one to a dozen farms.

The loss to crops from improperly distributed rainfall in this state is enormous. In many places water could be economically stored during the wet seasons, to be used for irrigation purposes when the rains fail. In other localities, the underground supply of water might be profitably utilized by a proper method of pumping.

The protection of life and property against floods is a matter of serious importance, and commends itself to our favorable consideration. Water purification and sewage disposal are as yet unsolved problems for the greater proportion of the state.

Tests should be carried on to determine the draft and efficiency of farm implements with the expectation of establishing standard designs for the different conditions of soil.

Kansas produces gas, oil and coal in large quantities. Much of this has been wasted in the past and is being wasted under present conditions. A series of tests conducted on a commercial scale will do much towards establishing standard methods for the preparation and use of these materials.

The gasoline engine will, for some time to come, be the principal prime mover for small units in this state. The cost of gasoline is constantly increasing. Under present conditions denatured alcohol can not be used economically. Investigations that will lead to methods of manufacture of denatured alcohol at a low price, and to methods of producing gas from Kansas coal successfully, will do much to extend the use of this type of engine and to cheapen the cost of power.

THE COUNTRY ROAD

Of more importance than all of these is the country highway. We have, through long use, worn out the natural roads, and have not yet found a successful substitute. Through the recently created department of public highways of the college, however, it is expected that we shall be able to educate the people concerning the importance of this matter. Moreover, through this means the college is now pointing out the most satisfactory way of maintaining earth roads, imparting information in regard to the best systems of permanent culverts and bridges, and as rapidly as the people of a community will assume the cost, will supervise the construction of permanent roads.

At all times the people have been found

ready to pay taxes for permanent public improvements, if they are confident that the money will be judiciously expended. It is through careful supervision by the experts of the college that the ordinary mistakes of the planning and construction of these highways and bridges will be avoided.

PRODUCTION AND DISSEMINATION OF IMPROVED PLANTS AND ANIMALS

The colleges of agriculture must lead in plant and animal improvement. A plan of improvement instituted by an individual is seldom carried beyond his lifetime. In a college, if well managed, a program of improvement may be carried forward without interruption for many generations, indeed indefinitely. It will be highly profitable for the state to encourage the more general use of better farm crops and live stock, by disseminating these improved strains, through the college. Already a large impress has been made upon the agriculture of Kansas, in both plants and animals, and experiments are now in progress which it is confidently expected will yield even more important economic results.

THE EXPERIMENT STATION

The primary function of the experiment station is to extend the domain of human knowledge. It has been the chief factor in creating agricultural knowledge. It was the experiment station which won back to the college the confidence of the farmer, which confidence had been forfeited for lack of ability to lead him.

It is the experiment station which has supplied the teacher with accurate and well-organized knowledge to impart in the class room. It has been the experiment station which has provided the way for these institutions to become real leaders in the realm of agriculture and has exerted an influence upon agricultural practise that is epoch-making.

It is an admirable work to turn out young men trained for leadership on the farm and capable of going among farmers as teachers of correct systems of agriculture, or to lead young men who come to the college to a better knowledge of the subject; but, after all, the greatest work these colleges have to do is to equip men with the proper knowledge and the necessary inspiration to advance the world's knowledge and to supply these thousands of teachers with something to teach.

It is, therefore, a fundamental mistake to assume that the duty of the experiment station is solely or even principally to benefit the farmer directly. A larger responsibility rests upon it—that of making an exact science of agriculture, so that it may be successfully taught in the colleges, the high school, the graded school, the farmers' institutes, and on demonstration farms.

The value of research is not limited to the industries. It is the very life of a teaching institution such as this. It gives point to the instruction. The teacher who is an investigator is a live teacher; no man can long keep alive as a teacher and not conduct researches.

RESEARCH TO ENCOURAGE MANUFACTURES

But research in these institutions has been restricted to too narrow a field. Little attention has been given to problems other than production problems. The effort has all been in the direction of making two blades of grass grow where one grew before; or of increasing man's efficiency with this or that machine. The time has come when its influence should be materially extended. The wastes of a rural community are not all to be found in the processes incident to production. An equal waste occurs in the marketing and utilization of the materials produced.

The investigations should, therefore, include agricultural manufactures and the

utilization of the wastes on the farm. Factories should be developed in the country, near the sources of production, for the preparation for final consumption of the materials grown on the farm. Such factories are necessary for the highest degree of economy in the production of food and to give the laboring man an opportunity to gain a livelihood outside of the congested city. Foodstuffs are already too high to stand the strain of the additional cost of transporting the raw materials long distances in order that they may be manufactured into edible form, then shipped back to the consumer in the very community in which they were grown, and where their manufacture might have been accomplished to better advantage.

In countries where the raw materials of our foodstuffs are chiefly grown, there they should be chiefly manufactured. Kansas wheat should be milled in Kansas. Just as the experiment station has made a profound impress upon the methods of farming, so may it improve the methods of manufacturing the products of the farm. The millers of the state need just such scientific assistance as the station can provide, all with a view not so much to helping the miller directly as to improving the quantity and quality of the foodstuffs garnered from the Kansas wheat fields.

THE ECONOMICS OF MARKETING

Such vital questions as how to dispose of the products that they may yield the largest returns, or how to spend the income so as to bring the best results in the highest sense, have been practically neglected.

To correct this one-sided development and meet this larger demand, the department of history of the college should be so strengthened and enlarged as to cover, both by instruction and by research, the industries of our country. The department of economics should be prepared to fully cover the range of transportation, manufactures, marketing, etc., as they relate to the farming and industrial classes. The department of sociology should deal with the life of the people in the open country and in the districts supported by the industries, and be able to suggest plans for their immediate and permanent improvement.

The department of architecture should make a large impress upon the homes and public buildings of the state, and upon the location and arrangement of the accessory buildings that they may conserve the strength of the housewife, afford the sanitary conditions essential to health and add to the comfort and pleasure of country life.

AMERICANS LIVE WASTEFULLY

Americans, poor and rich, live wastefully. This can not continue. A new basis must be established which shall, while avoiding the extreme care and economy of continental Europe, which destroys initiative and kills pride, stop the major wastes in our system of living.

But of more importance than mere economy of living is the influence of the environment and method of living upon the race. Will out of it all in the long run come a strong and virile race of people—a race capable of meeting the complex problems of the future and advancing still further our civilization?

It is especially appropriate to emphasize this point in the institution which, among the land-grant colleges at least, has been a leader in this line, and which to-day boasts the largest and perhaps best equipped department of domestic science and art in America.

As much, however, as has been done in this direction here and elsewhere, and proud as we have a right to be of the record of this college in this direction, real

work has been hardly begun and we scarcely realize what this great movement means and what will be its future development. Certain are we, however, that it means something more than the mere teaching of young women how to sew and how to cook. It has involved in it the whole question of home building and the rearing of a strong and virile race of people. The dream of the ancients, a strong mind in a sound body, is thus beginning to be realized. But we have only just come to take this view of the matter and have scarcely begun work on this broad basis. Times are strangely out of joint when we justify the extensive scientific inquiries into the way to rear a strong and vigorous race of pigs or sheep or colts or cattle, and are content with the very meager knowledge which we possess of the nutrition of men. We have millions for research in the realm of domestic animals, and nothing for the application of science to the rearing of children. Exhaustive studies are made upon the life histories of animals of the lower orders, while vital facts in regard to the life history of our children remain a sealed book. We know how the *amœbæ* develop, but are content to remain in ignorance of what factors contribute to the development of a strong body and a sound mind in mankind. For centuries we have let the injunction "Know thyself" go unheeded, and have forgotten that "The greatest study of mankind is man."

For every dollar that goes into the fitting of a show herd of cattle or hogs or into experiments in feeding domestic animals, there should be a like sum available for fundamental research in feeding men for the greatest efficiency. The Kansas State Agricultural College ought to take advanced ground here, and build up the greatest institute of research in human nutrition in the world. The federal government should be interested and cooperate with the state and community in matters of this sort.

THE EXODUS FROM THE FARM

It is common to lament the tendency of the best men and women to leave the farm and go to the city as a modern or present-day tendency, whereas it is as old as civilization itself.

> Plutarch in his "Præcepta Politica" protested against the threatening invasion of large cities; Cicero thundered against the depopulation of the rural districts through similar attractions to those which draw young men and young women from the farm to-day. Even Justinian, the great law maker, was in favor of legislation designed to keep the people on the farm.

The great Roman Emperor Augustus before the Christian era saw that his empire was being undermined and the strength of his people sapped by the exodus from the country to the city, and called to him the poets of the nation and commanded them to sing of the beauties and profits of country life, in order to attract his people back to the land. This trend cityward has been to a great degree due to the half education which has prevailed in the rural districts and which has given the farm boy glimpses of the more attractive city life without teaching him at the same time how he may attain such a life at home.

For the first time in history this situation is sought to be met by making a profession of farming, so that it may be attractive to the intellectually strong, at the same time that the returns are large enough to command the reasonable comforts and luxuries of life. These countervailing influences, however, will be found to be inadequate unless they strike at the very root of the difficulty—the farm home, the country road, the rural school and the country church.

VOCATIONAL SUBJECTS IN THE PUBLIC SCHOOLS

This means that vocational subjects must be introduced into the courses of study in the grades and in the high schools, as well as in the colleges and in the universities. So rapidly and so fully has instruction in vocational branches been developed, that the best and cheapest places to learn farming or stock raising or dairying is now, not on the farm, but in a college. The horse doctor has been displaced by the college-trained veterinarian. The place to learn to sew and to cook and to build and manage a home is, not in the home, but in a college. The period of apprenticeship of the machinist has been supplanted by a course at college, and the employers of engineers no longer look elsewhere than to the colleges for this training. But gratifying as all this is to us, we must realize that at best the problem of bringing industrial education within the reach of the masses, and this is the great problem, is very far from being solved. In the nature of the case, but a small proportion of the people can attend college. It has already been pointed out that less than a dozen of every thousand pupils in the graded schools go to college. When we consider that these twelve are divided among the various courses offered by our colleges and universities, such as academic theology, law, medicine, teaching, journalism, agriculture, engineering, etc., we realize how small a proportion of the boys and girls of the country really come under the influence of this sort of instruction when it is confined to the college. To reach the masses with this work, it will be necessary to introduce it into the high schools and grades the country over. In the city schools, home economics and manual training, with agriculture optional, and in the country schools, home economics and agriculture, with manual training optional.

To the objection that these subjects, especially home economics and agriculture, of a character suited to the grades and high schools, are not yet teachable, I urge that they are far more teachable than were these same subjects of college grade twenty years ago, and that if we will apply ourselves to the problem of reducing them to pedagogical form with the same zeal and determination that characterized the efforts of the college teacher, equally satisfactory results will be forthcoming.

To the objection that the teachers are not prepared, I answer that the demand for teachers so prepared is all that is necessary to fully meet this difficulty.

INDUSTRIAL SUBJECTS IN HIGH SCHOOLS FIRST

Success will come first in the high school, and next in the grades, for the same reason that it came first in the college. The high school to-day must be something more than a mere connecting link between the graded school and the college or university. It is more than the successor to the academy with the burden of support laid upon the public. It is in the strictest sense the people's college, and affords the highest education that the majority who go beyond the grades will ever get. It should do something more than merely fit for college the great masses who will never attend college; it should fit for the duties of life.

Already the city high schools have reached a fair degree of development in this direction, and the trend towards the industrial and vocational has been as rapid as could be expected or as is perhaps desirable. Their courses of study are already reasonably well adapted to the needs of the people who live in the city. It is a serious mistake, however, to pattern too closely after these city high schools in planning to meet the needs of those who live in the country. Careful consideration

should be given to the pupil's environment and experience as well as to his probable future occupation.

AGRICULTURE IN THE RURAL SCHOOLS

This is the next great educational problem. In fact the rural school to-day, considered broadly, presents the most serious educational problem with which we have to deal. How to shape the instruction in this unorganized, isolated and poorly equipped school so that the pupils may not lose sight of the farm, its life, its problems, its beauties, and its profits, is the great question now before us. The hope of these schools and of our system of public education lies, not in the abandonment of these country schools, not in the attempt to substitute something else for them, but rather in making them serve their constituency in the best way and contribute most to the development of the boy or girl who is fortunate enough to have been born in the country.

The problem does not consist in the long run wholly or even mainly in finding a suitable teacher, although this is perhaps for the moment the limiting factor in progress.

As Professor Bailey has well said:

> If a room or a wing were added to every rural school house, to which children could take their collections and in which they could do work with their hands, it would start a revolutuion in the ideals of country school teaching, even with our present school teachers.

In short, our rural school system needs to be so revised that from the very outset the courses, to quote the words of a distinguished English educator, "shall be woven around knowledge of the common phenomena of the world. . . . For it should be the purpose of these elementary schools to assist boys and girls according to their different needs to fit themselves practically as well as intellectually to the work of life."

I do not wish to be understood, in quoting the foregoing approvingly, to advocate the making of the graded or high schools narrow or provincial. Nor would I permit these schools to become in any sense professional—except possibly the last two years of the course in a first-class high school. This might appropriately be made as severely professional as the funds for providing the additional teachers and equipment would permit.

INDUSTRIAL SUBJECTS WILL VITALIZE

The benefits to accrue from the successful introduction of agriculture, home economics and manual training into the schools will not be confined to the direct influence which this instruction may have upon the industries involved, but this will be found to be the best way to vitalize elementary schools, and especially those in rural communities. Just as these useful subjects gave new life to our college courses, so will they be found capable of vitalizing the elementary courses.

TRAINING THE TEACHER

As before intimated, the lack of suitably trained teachers for this work is temporarily the limiting factor in our progress. Where the teacher shall receive his training, and of more fundamental importance, of what it shall consist, are questions not yet answered. Thus far no very satisfactory place for securing this training has been provided. A number of agricultural colleges of the country are offering courses in agriculture, etc., especially for teachers, and these in the main have been successful.

Congress recently recognized this lack in our educational system, and provided, in the Nelson amendment to the Morrill Act,

that a portion of the increased support thereby given the colleges of agriculture might be used for "providing courses for the special preparation of instructors for teaching the elements of agriculture and mechanic arts."

Whether experience will in the end show that the normal school, with agriculture, home economics and mechanic arts added, or the agricultural colleges, with sound courses in education added, will best meet this situation, or whether it may not indeed become expedient to employ both methods, I will not at this time hazard a guess. We are all, I take it, more interested in having this work done and done well, than in the question of where or by whom it shall be done. Certainly there are many people now teaching who desire to equip themselves to teach agriculture. These naturally would be best served by courses at the agricultural college.

EXPERIMENTS IN TEACHING INDUSTRIAL SUBJECTS

To my mind, there can be no question as to the propriety and profitableness of establishing at the agricultural college, where agriculture, home economics and mechanic arts reach their highest development, and where there is the greatest interest and enthusiasm in these subjects, systematic investigation of the methods of teaching these subjects of a grade suitable to the requirements of high schools and rural schools. A sort of pedagogical experiment station for the systematic study of these and kindred problems is no less important than are agricultural experiment stations, to study questions relating to corn and wheat growing and the raising of live stock, and no less logical than engineering experiments to study questions in relation to bridges, highways, sanitation, etc.

KANSAS'S OPPORTUNITY

Much as we may deplore the lack of suitably prepared teachers to introduce these vocational subjects into the schools of the rural districts, and much as we may feel the lack of adequate knowledge and experience along this line, the really fundamental difficulty in the way of a satisfactory system of rural schools, primary and secondary, is the lack of sufficient funds. Wealth in rural communities is not sufficiently concentrated to afford the revenue necessary for this purpose. In many portions of the country the returns from the farm are so meager as to scarcely permit the schools to be maintained on their present low plane. The farmers of Kansas, however, are prosperous—perhaps more prosperous, on the average, than the farmers of any other section of the world. They therefore owe it to themselves, to their less fortunate neighbors, and to their profession, to give of their means in sufficient amount to develop the most efficient system of rural education the world has known.

FARMER OR PEASANT

It is not primarily a matter of increased financial return, but has involved in it the future welfare of America's agriculture. Further advancement must be based upon the increased intelligence of the man who is to till the soil, together with his better understanding of the fundamental laws of nature with which he has to deal.

If the American farmer is to prove an exception to the history of the world and remain the independent, thinking, reading, progressive individual that he has thus far been instead of becoming a peasant, as he has before in all history, it is necessary that he be given the broadest possible training, and be educated most thoroughly in the fundamental principles underlying his profession.

THE INDUSTRIAL AND THE CULTURAL MUST GO TOGETHER

It is said that an ancient and honorable university once wrote over its portals: "No useful knowledge taught here." I would not go to the opposite extreme and write over the portals of even this institution—the child of a strictly utilitarian age—the legend: "No subject that is not useful taught here." I would make all the courses practical enough to fit men for efficient service in their several professions and pursuits of life, and at the same time liberal enough to prepare them for the highest service as citizens.

The best part of an educational institution is its spirit—is the point of view which it gives its students—the ideals which they carry away from its halls and through life, for of more worth than fine gold is a quickened conscience and a capacity to distinguish between what is right and what is wrong.

A high ideal is the noblest gift man can bestow upon man. Feed a man, and he will hunger again; clothe him, and he will become naked. Give him a noble ideal and that ideal will abide with him through every waking hour, giving him a broader conception of his relation to his fellows. The ideal must be so far above us that it will keep us looking upward all our lives and so far in advance that we shall never overtake it.

Those whom we send out must make a large contribution to the welfare of the world.

GREAT TEACHERS MAKE A GREAT SCHOOL

We point with a pardonable pride to our splendid group of buildings, the broad expanse of fertile soil which constitutes the college farm, the improved plants and animals, boasting of both a distinguished lineage and an honorable career, to the shops and equipment of laboratories and libraries, to the new athletic fields and gymnasium in immediate prospect, and to our other material possessions, and unconsciously make the sum of these, the college.

It is, however, the teacher who determines the worth of the school. We have no means of measuring the value of a great teacher. It was in the musty law office of John Wythe that Thomas Jefferson studied, as did also one of the greatest judges that ever sat upon the supreme bench, John Marshall, and also the greatest orator that ever electrified an audience in his period of the world's history, Patrick Henry. John Wythe was himself chancellor of Virginia, and a great man, but great chiefly for the men he made.

Given a good teacher, and locate him in a cellar, an attic or a barn, and the strong students of the institution will beat a path to his door. Given a weak teacher, and surround him with the finest array of equipment that money can buy, and permit the students to choose, as in the elective courses, and his class room will echo its own emptiness.

A poor teacher in a German university, where all subjects are elective, is a matter of comparative indifference, but in an institution such as ours, where the courses of study are fixed, to keep a poor teacher year after year and require hundreds of young men and women to waste their time in his classes, is little short of a crime.

Economy in teachers' salaries is false economy, and will quickly react upon the institution and upon the state. Low salaries mean cheap teachers and low-grade work. The twenty-five hundred or more students who come here annually to secure an education have a right to demand the best. To lose our best teachers the moment we have developed them to a high degree of efficiency, because we can not meet the salary paid in kindred institutions is deplorable in the extreme. Or to secure good teachers and so load them with work

that they can not render the most efficient service is an equally poor policy.

It should be the business of those entrusted with the administration of a college to secure the best men available, supply them with such facilifies as will make them content, and then have the wisdom to let them alone.

WORLD LEADERSHIP REQUIRED

Large and important as is the service this institution has rendered to the industries of the state, and great as are the problems of this sort for the future to solve, the service of greatest moment, the principal return which the Kansas State Agricultural College and similar institutions make for the large outlay of public funds—the real justification for their existence—is their capacity for developing in men and women the qualities of leadership. The public mind does not grasp and successfully grapple with great fundamental principles, but is apt to concentrate itself upon some detail—of one sort to-day, of another to-morrow. It is essential that we have leaders of public thought who see broadly and clearly, for, as Mirabeau says, "It is equally as important for those to be great thinkers who are to execute the laws as for those who made them." Homer realized the scarcity of such men, and, as given us by Pope, said:

Too few and wondrous few has Jove assigned
A wise, extensive and all-consid'ring mind;
They are guardians, these, the nations round confess,
And town and countries think their safety blest.

Situated as we are, in the very center of the largest expanse of fertile land the world has, with a climate neither so warm as to weaken nor so cold as to dwarf, but the climate which has produced the most virile and progressive races of people—the races which have in all recent history dominated the world, no one can foretell what the future holds. Certain it is that here will be the greatest concentration of population and wealth. Here all things for which we are striving must reach their highest development. No longer will it be necessary for us to look to the east or to Europe for inspiration and guidance in education, in engineering, in agriculture, in how to live rationally. In very truth, the men of the east and of Europe will come here to learn. This means that the men of to-morrow, the young men who are now in school, must assume larger responsibilities than have devolved upon us—the responsibilities of world-leadership in the entire range of human affairs. It is imperative therefore that our systems of government, education, agriculture, manufactures, etc., shall be such as to withstand the severest test of science and human experience in order that they may furnish a rational example and guide for those less blest.

COLLEGES MAKE LEADERS

In the absence of a great epoch or crisis in human affairs, such as the opening up of a new continent, the invasion of a country by a foreign foe, or an internal strife such as our recent civil war, the college and university must be depended upon to develop the world's leaders in all lines of activity. The state and nation, to make certain that every youth with latent qualities of leadership may have within his reach, be he poor or rich, the uplifting and stimulating influence of the highest education the world affords, did establish and endow this and kindred institutions. It is upon this basis only that our civilization can be secure. No class of people, however large, cultured, or refined, is large enough, or intellectual enough, or refined enough, to supply all the leaders the state and nation require. It is only when all are drawn from all classes that we shall have enough, and be certain that we have

the best. It is as Carlyle has said of the tragedy of ignorance:

It is not because of his toils that I lament for the poor; we must all toil, or steal (howsoever we name our stealing), which is worse; no faithful workman finds his task a pastime. The poor is hungry and athirst; but for him also there is food and drink; he is heavy laden and weary; but for him also the Heavens send Sleep, and of the deepest; in his smoky cribs a clear dewy heaven of Rest envelopes him, and fitful glitterings of cloud-skirted Dreams. But what I do mourn over is that the lamp of his soul should go out; that no ray of heavenly, or even of earthly knowledge should visit him; but only in haggard darkness, like two spectres, Fear and Indignation bear him company. Alas, while the Body stands so broad and brawny, must the Soul lie blinded, dwarfed, stupefied, almost annihilated? Alas, was this, too, a Breath of God, bestowed in Heaven, but on earth never to be unfolded?—That there should one Man die ignorant who had capacity for knowledge; this I call a tragedy were it to happen more than twenty times in the minute, as by some computations it does. The miserable fraction of Science which our united Mankind, in a wide Universe of Nescience, has acquired, why is not this, with all diligence, imparted to all?

Mr. President: Assured as I am of the loyal support and cooperation of the board of regents, faculty, students, alumni and citizens of this great state of Kansas, at the same time realizing the full weight of its responsibilities, and conscious of my own limitations and weakness, and pleading for both charity and patience, I accept the high office of president of the Kansas State Agricultural College. May He who marks the sparrow's fall take us all into His keeping and guide our thoughts aright.

PHYSICS TEACHING IN THE SECONDARY SCHOOLS OF AMERICA[1]

WE understand the present fully only in the light of the past. Hence, if we would grasp the meaning of the present situation so clearly as to be able to see the way out, we must first study the history of science teaching in America.

Mathematics has had a long and an honorable academic career. But the natural sciences are relatively new as subjects of formal instruction in schools. Although physics appears to have been taught to freshmen at Harvard for two fifteen-minute periods a week as early as 1670, the sciences do not appear on the list of subjects required or accepted for entrance to college until the year 1870, when Harvard added the elements of physical geography to its list. Physics appeared in 1876. The demand for popular and useful studies had led the academies to introduce the sciences of geography, natural philosophy and astronomy early in the nineteenth century. The colleges did not recognize these, however, till about fifty years later.

When we remember that the academies were founded in response to a popular demand for an education that should train boys and girls so that they might be useful members of the community, we see: (1) That the sciences were brought into the schools for their practical utility; (2) that the colleges followed the schools in their recognition of the value of science after an interval of about eighty years, and (3) that science was introduced into the schools in response to a demand on the part of the people who supported the schools and in spite of the colleges.

In order to make clear the subsequent development, I shall consider largely the subject of physics, partly because physics has been more prominent in the schools; partly because I am better able to follow its changes with sympathy; and also because I believe that the history of physics is typical of that of the other sciences. Let us then glance at the methods of teaching physics in 1876 when that science

[1] Address delivered at the conference of the University of Illinois with the secondary schools of Illinois, November 19, 1909.

made its début among the subjects required for admission to college.

We can get a very good idea of what was taught under the name of physics by examining some of the books used for texts like Comstock's or Wells's "Natural Philosophy," or Rolfe and Gillett's "Handbook of Natural Philosophy." This latter work was the one specified for use in preparing for the entrance examination at Harvard, so we will use it for purposes of comparison.

The Rolfe and Gillett contains two hundred and thirty pages, exclusive of the appendix which was not required. The modern texts, Millikan and Gale, Adams, Mann and Twiss, contain, respectively, 482, 478 and 456 pages; on the average, an increase of over 100 per cent. In like manner the number of numbered paragraphs in the required portion of the Rolfe and Gillett is 351; that in the modern texts just mentioned is 614, 560 and 416, respectively, an average increase of about 50 per cent. It thus appears that the amount of subject matter that has been crowded into the course has been very materially increased. It is a noteworthy fact, however, that this increase consists in the addition of new topics rather than in the change of old ones for new, *i. e.*, the old course given in 1876 contained only the necessary elements of any course, because modern developments have failed to displace them.

The first great change that has taken place since physics became a college entrance subject has been this great increase in number of topics considered necessary for the course. The present course is acknowledged on all sides to be badly overcrowded. Can any teacher make twenty or more pupils master or even learn thoroughly and clearly understand 614 numbered paragraphs, each containing, by reason of being numbered, a new idea or principle, in 180 forty-minute periods? This means just eleven minutes and 43.6 seconds to a paragraph—and this interval must include all the discussion, problems, experimental demonstrations, quizzes and laboratory work. Is it a wonder that teachers who attempt this do not succeed? And this without reference to the content of the paragraphs. Under such conditions it is far less remarkable that 70 per cent. of the applicants fail on the written examination of the College Entrance Board than it is that 30 per cent. pass.

Are the college entrance requirements responsible for this overcrowding of the time allotted to the course? This is a leading question and it may be answered by either yes or no, according to the interpretation put on it. If you treat it as a legal question, as a question of whether "it is so stated in the deed" or not, the answer will be an unequivocal no. The early Harvard requirements and the definition framed by the National Educational Association and that issued by the College Examination Board have never contained any syllabus of topics required. Hence this superabundance of topics is not written in the deed and the college requirements are not to blame. There is one exception to this statement and that is New York University, which has issued a syllabus of required topics. This syllabus is a model of logical arrangement, but is at least twice as long as any syllabus for a one-year course in physics should be.

Well, then, if the college requirements are "not guilty" in the documentary sense, what has been the source of the congestion? It is, of course, impossible to lay all the blame on any one thing, because the conditions under which this overcrowding has developed have been so complex. All will agree, however, that the first cause is

to be found in the fact that the science itself has made such rapid progress since 1876. This development of the science has been paralleled by a remarkable growth of the spirit of scientific research and a large increase in the number of specialists in physics who are devoting their entire time to investigation in this field alone. Add to this the attitude of the universities toward research in that they demanded research work of their physicists as a prerequisite to academic promotion, and you have all the elements necessary to crowd more and more subject matter into the preparatory course. The teachers in the schools caught the spirit of the universities, and all hands turned to a well-intentioned but, as it has proved, a futile effort to introduce into the elementary course as much of the precision, the rigor and the abstraction of the research laboratory as was possible. The highly specialized science of physics became king and the abilities and needs of the pupils were lost sight of.

This development was fostered by textbook writers, publishers and apparatus dealers. Every new text had to go its competitors one better in the matter of being "up-to-date," in order that the publishers' agents might have new "talking points" with which to allure the unwary superintendent or school-board member. No publisher would print a book that did not contain accounts of all the recent discoveries and a few more, because the publishers had found out that teachers would turn down a book because it did not contain X-rays or wireless telegraphy, ions, electrons or radium. Up-to-date-ness was considered the first virtue.

Another example of this increase in the amount of subject matter may serve to leave this first point clear in mind. The 1888 edition of Gage's "Introduction to Physical Science" contains 340 pages and 321 numbered paragraphs. Under the pressure of up-to-date-ness, Gage wrote an enlarged book called the "Principles of Physics," and the latest revised edition of this book, 1907, contains 529 pages and 562 numbered paragraphs. Thus we see that, although the abilities and tastes of the pupils have remained fairly constant, and although little effort has been made to prepare them for the work by teaching more elementary physical science in the grammar schools, the amount of subject matter that we are trying to teach them in the same time has increased from 50 to 60 per cent. This increase alone is enough to make it impossible for the teacher now to do thorough work, without regard to the nature of the topics added or to the content of the subject matter. This one thing is enough seriously to have impaired the efficiency of the science work.

Nevertheless, this increase in the amount of the subject matter is by no means the only factor that has been at work in rendering the science teaching less effective than it might be. When we compare the subject matter taught thirty years ago with that in the modern texts as to content, we find again a marked contrast.

Thus by comparing the topics under "a" in the index of the Rolfe and Gillett with those in the index of the latest of the new texts, that of Adams, I find but two topics in the former not treated in the latter; and thirty in the new book not found in the old. The old topics omitted are *annealing* and *artesian wells*. The most important new topics introduced are *aberration, chromatic and spherical; absolute temperature, absolute units, acceleration, air thermometer, alternating currents, ammeters, astigmatism, Atwood machine*. These few give an idea of the sort of things that have been added. A

similar proportion holds for the rest of the indices.

It will be noted that the topics omitted in the new book are of the "practical" type—annealing and artesian wells, while most of those added in the new book treat of unfamiliar subjects not likely to be met with outside the physics laboratory—spherical aberration, absolute temperature, absolute units, air thermometer, Atwood machine—topics of a highly specialized type demanding the use of abstract, difficult, and to the pupils, unusual ideas for their mastery. When we recall that the teacher has just 11 minutes and 43.6 seconds in which to make each topic clear to a class of twenty or more, we need not be surprised that the students find the subject unintelligible, and that they carry away only a rather confused jumble of words in the place of clear, definite and usable ideas.

Because these technical topics are unfamiliar, the student does not see their use or value—and many of them are useless to the majority of the pupils—so they have no significance to him, and hence he has no motive that impels him to study them with enthusiasm.

An example may help to make this point clearer. In the early editions of Gage the problems are of this type: "What amount of work is required to raise fifty tons of coal from a mine two hundred feet deep?" "Twelve hundred foot-pounds of energy will raise a one-hundred-pound boy how high, if none of it is wasted?" In the most recent books we find problems like this: "How much work is done in lifting a 10 kg. mass vertically 180 cm.? Give the answer in kilogrammeters, in ergs and in joules." "What force in dynes will lift a mass of five kg.? How many ergs of work are done in lifting a mass of 5 kg. 20 cm.?" "A pull of one dyne acts for 3 seconds on a mass of one gm. What velocity does it impart?" Or again, in the Rolfe and Gillett, Newton's second law of motion is stated thus: "A force has the same effect in producing motion, whether it acts on a body at rest or in motion, and whether it acts alone or with other forces."

The modern text states this: "Rate of change of momentum is proportional to the force acting, and takes place in the direction in which the force acts." If we did not understand Newton's law, but were trying to learn it for the first time, which of these statements would be the more intelligible? Which would leave us with the clearer and more usable idea? The latter statement has been introduced for the sake of greater rigor; but taking it simply as an English sentence, have we gained in rigor by making the student memorize the statement that a *rate of change* takes place in a certain *direction?* This statement of the law is what Carl Pearson in his "Grammar of Science" calls a metaphysical summersault. And have we not thereby converted the old and valuable "science of things familiar" into a "nescience of things familiar"?

Hence the second important fact in the development of the teaching of science is that we have not only added to the number of topics to be learned, but have also changed the content of the old topics so as to render them almost, if not entirely, unintelligible to beginners. Any one who has taught classes of teachers in a summer school, or has visited elementary classes in physics, must have noticed that many of the "laws and principles" of physics, as they are expounded in the modern texts, are none too intelligible to many of the teachers themselves. How then can we expect to have the pupils leave their work with clear, definite, usable ideas? This change

in the content of the ideas presented, or of the point of view from which the phenomena are now presented, would alone account for the decrease in the success and efficiency of physics teaching in the past decade. Elementary physics has lost much of its pragmatic value and become somewhat rationalistic because of its devotion to various and sundry "absolutes."

But besides the increase in the amount of subject matter and the "absolute" unintelligibility of some of it to beginners, there is a third great and important fact in the history of physics teaching in America. This fact is that the method of presenting the subject has changed in several important ways. We can get a good idea of the condition of physics teaching in the secondary schools in the seventies from two bulletins that were issued by the National Bureau of Education in 1880 and 1884, respectively. The first was edited by Professor F. W. Clarke, of the University of Cincinnati, and it contains reports concerning the teaching of physics and chemistry from 176 public and 431 private secondary schools. From a study of this report it appears that in 1880 there were but four of the 607 schools giving a full year of work in physics with laboratory experiments by the pupils. Fifty-three were giving full year courses with experiments by the teacher. One hundred and thirteen were giving courses in physics with no experiments at all—merely text-book recitations. The rest had courses for part of a year only, but almost all had some physics.

It is not necessary to make any comment on the difference between this situation and the present one, where practically every school has its laboratory work by the pupils. This change from practically no individual laboratory work to laboratory work for everybody means, as every science teacher must see at a glance, a tremendous advance. It is also clear that the college entrance requirements have been of the greatest assistance in hastening this progress. Beginning in 1886 with the Harvard requirements, and followed up in 1897 by the definition of the unit requiring laboratory work by the committee on College Entrance Requirements of the National Educational Association, the colleges have contributed all that in them lay toward the acquisition of this very valuable asset for science teaching. A detailed account of how the college requirement was framed and how it has been altered has been given by Professor E. H. Hall, of Harvard, in his book on the "Teaching of Physics," and more recently in his contribution to SCIENCE for October 29, so that we need not pause for this now. Suffice it here to point out that physics teaching owes a great debt of gratitude to the colleges generally, but to Professor Hall and Harvard in particular, for this acquisition of laboratories for physical science in the schools. By the introduction of the laboratory work the teaching of science has been enormously benefited; and, had the teachers held the subject matter of the course down to the comprehension of the pupils, there would doubtless be no cause for complaint now.

The second of these bulletins from the bureau of education was edited by Professor C. K. Wead, of the University of Michigan, and deals largely with methods of instruction. It contains replies to a circular letter issued by the bureau, a discussion of these replies, a number of reports on physics work abroad, some valuable suggestions on teaching of physics, and a list of forty-seven topics and forty-two experiments, which were regarded as fundamental for every elementary physics course. It is interesting to note that this list, issued in 1884 by the U. S. Bureau of

Education, contains three quarters of the topics on the list of the North Central Association which was issued in 1908. It is not seriously different from the truly celebrated Harvard description list of 1886, or the list of experiments in the new College Entrance Board's requirements. The report also shows that twenty-five of the thirty secondary schools reporting expressed themselves as regarding laboratory work as necessary. This shows a great advance between 1880, when the Clarke bulletin was issued, and 1884. Thus laboratory work was being introduced rapidly before the college pressure was applied in 1886, and the reports show that it was of a kind to possess significance to the pupils —done with home-made apparatus and "kitchen utensils."

This report contains much valuable advice which has not been followed in the subsequent course of events. Thus, p. 116: "Above all, it should be taught in each kind of school for the benefit of those who will go no further." Again, p. 117:

> The weight of opinion is decidedly that the first teaching should be inductive. . . . The progress of the student following this method is so slow, if measured by the usual examination tests, as to discourage a faint heart. . . . When pushed to the extreme just indicated (to learn everything for himself) the method breaks down; for quantitative experiments are mostly beyond the reach of high school boys, and yet very few principles or laws can be established without them. . . . If to reason accurately on physical facts be of any value to the student, is not a conclusive disproof of an hypothesis (provided he originated it) more valuable than the incomplete proof with which he must usually remain contented when he learns the accepted hypothesis? . . . Consciously or not, we must use inductive methods all our lives in ways where we can not avail ourselves of the principle of the division of labor, depending on others. The professional opinions of the physician and lawyer, all our judgments of men and our opinions on common matters of life must be largely the result of inductive reasoning. Another reason for introducing inductive training into the schools is that, in the opinion of many teachers, more of physics can be taught so as to be remembered in this way than in any other. . . . The use of text-books of the ordinary kind, however accurate and clear, is inconsistent with, perhaps almost fatal to, the scientific method in schools.

Again, p. 103:

> The difference between certainty and probability or conjecture, between truth and opinion, is one which the educator would not fail to make felt. . . . To keep the scholar in an atmosphere of real or apparent certainty, when in after life three fourths of his intellectual occupation will be to deal with uncertainties, is as foolish as it would be to keep him out of the water until he has learned to swim.

Thus in the matter of facilities for presenting the subject of physics, substantial progress has been made in the acquisition of the laboratory; but in the matter of knowing how to treat the subject, we have made little progress—many think we have gone backward.

Somehow most of the students regard the subject matter as so much "stuff" that has to be gone over, and speak of the laboratory exercises as so many "stunts" that have to be performed in order to get credit. The work as a whole lacks significance to them, so that they do not, as a rule, work at it with initiative and enthusiasm. The present condition was sized up so aptly by President Remsen in his address before the American Federation of Teachers of the Mathematical and the Natural Sciences in Baltimore last year, that I can not refrain from quoting him:

> A battle that has long been waging has been won—the battle for the recognition of science in the courses of study in schools and colleges. . . . Now science is recognized; we have laboratories everywhere and laboratory training is regarded as indispensable. It is therefore fitting to ask: What are we doing with our facilities? What results are we obtaining? When the battle was on, men lost their heads—men must lose their heads in order to fight. We thought that if only we could

get laboratories, the problems of education would be solved. Is this true? Are we doing the best that is possible with what we now have? Do the results obtained justify the equipment and time devoted to scientific study? I am not qualified to answer these questions for the schools; but speaking for the colleges, I may say that in my opinion the results are frequently quite unsatisfactory. The reason is that we have not yet learned how to deal with the subject. It is not hard to teach chemists chemistry, but it is very hard to teach beginners something that is worth while about chemistry in one year.

The leading facts of the past history of science teaching and the present problems are now before you.

We have not yet learned how to deal with our subject. It is not hard to teach physicists physics, but it is very hard to teach beginners something that is worth while about physics in one year.

It is essentially an educational problem, and, again quoting President Remsen's address:

Pedagogical problems are hard to solve—it is very difficult to get sound conclusions. How can we tell whether the scientific training is more effective than that of the older type? This is a problem that can not be solved by sitting down and thinking about it; it can be solved only by research and experiment. I do not myself know whether scientific training as now conducted is producing the results hoped for. Yet I am convinced that scientific training, when properly conducted, may be of the greatest value as an educational force. This is quite a different thing from saying that that particular thing now known as science training is of great value. It all depends on how it is done. I have been experimenting to find out how to teach chemistry, and it is the most difficult experiment I have ever tried.

"The problem can not be solved by sitting down and thinking about it;" nor, may I add, can it be solved by getting up a perfect list of experiments, or, by writing a text that shall be the most logical, accurate and rigorous in the world. "The problem can be solved only by research and experiment and it is the most difficult experiment I have ever tried." Progress in the future depends, then, on our applying to our teaching problems the methods of our subjects; for surely no one needs to tell a body of science teachers what the words research and experiment mean. How, now, shall we go about it?

The first step is to define specifically the problem we are going to try to solve. The problem as stated above, namely, to give the pupils something worth while, is too vague to permit of scientific experiment, because it offers no method of testing the work for the purpose of finding out whether we have succeeded. What do we mean by "something worth while," and how shall we test the pupil to find out whether he has acquired it? Those of our parents who studied physics in the sixties and seventies testify now that they acquired from their school work in physics an investigating attitude toward problems, and clear enough ideas of some of the more important principles to have helped them considerably ever since. But such evidence as this comes rather late, and, while it is interesting and throws some light on the subject, it is not the sort of evidence that science demands. The problem must be more specific and the results of the experiments must be more definite. We must therefore seek a more definite statement of the problem, and this necessitates first a decision as to what the purpose of the teaching is to be.

The number of purposes for teaching physics that have been suggested and defended in the past thirty years has been large. Two, however, have been rather more fundamental than the others, so we will confine our attention to these. The first in the public mind at present is the one given in the report of the Committee on College Entrance Requirements of the National Educational Association, to which the College Entrance Board gave until this year a protecting shelter. It is thus

written in the deed: "To the end that the pupil may gain a comprehensive and connected view of the most important facts and laws of elementary physics." This purpose leads to the very specific question: Do the pupils get such a view under the current system of instruction? This question can be answered—nay, is answered, with perfect definiteness on all the examination papers written by the pupils. Need I tell a body of physics teachers what the answer is? How many papers each year convince you that the writers have either a comprehensive or a connected view of the most important facts and laws? For myself, I do not hesitate to answer; very few; and, as a college teacher who must build on the comprehensive and connected view implanted by others, I must confess that I am seldom able to discover it. In some few students it is there, but in the great majority it is not.

Under these conditions it seems perfectly fair to question whether the present habits of teaching are sound and to try to find out what is the matter. Two sources of trouble have already been pointed out. In our efforts to make the view comprehensive, we have overcrowded the course to the point where we have but eleven minutes forty-three and six tenths seconds to a topic. In our efforts to make it connected, logically connected, we have become rationalists and resorted to the "absolute," thereby making much of it unintelligible. One scientific experiment would consist in reducing the subject matter, forsaking the absolutes, and then testing all along for the clearness of view gained. Another would consist in presenting the same topic to several different classes by different methods to see if some previously unintelligible topics might be made intelligible if differently treated. Numerous other experiments will at once suggest themselves, all aimed at finding the best way of "giving a comprehensive and connected view" of such facts and principles as were introduced. In this matter there is no royal road to success. Each teacher must find out for himself how best to succeed with his particular class.

The second important purpose of teaching science does not seem to have received much attention of late. It has not been a protected commodity like the other. Its statement is best given in a report of a committee on teaching of elementary physics that was presented to the British Association for the Advancement of Science in 1874.

They have assumed as a point not requiring further discussion that the object to be attained by introducing the teaching of physics into general school work is the mental training and discipline which the pupils acquire through studying the methods whereby the conclusions of physical science have been established. They are, however, of opinion that the first and one of the most serious obstacles in the way of the successful teaching of this subject is the absence from the pupils' minds of a firm and clear grasp of the concrete facts and phenomena forming the basis of the reasoning processes they are called upon to study. They therefore think it of the utmost importance that the first teaching of all branches of physics should be, as far as possible, of an experimental kind. Whenever circumstances admit of it the experiments should be made by the pupils themselves and not merely by the teacher, and though it may not be needful for every pupil to go through every experiment, the committee think it essential that every pupil should at least make some experiments himself.

For the same reasons, they consider that the study of text-books should be entirely subordinate to attendance at experimental demonstrations or lectures, in order that the pupils' first impressions may be got directly from the things themselves and not from what is said about them. They do not suppose that it is possible in elementary teaching entirely to do without the use of text-books, but they think they ought to be used for reviewing the matter of previous experimental lessons rather than in preparing for such lessons that are to follow.

It will be noted that the purpose herein set forth is the one favored by most of the contributors to Professor Wead's bulletin just reviewed. It seems to have been the prevailing idea prior to and at that time, 1884. As stated above, our parents tell us now that they actually did get from their study of physics an inquiring attitude of mind, and the ability to attack and solve problems. One of the correspondents in Professor Wead's bulletin states that the introduction of physics in his school has had the effect of quadrupling the number of boys that go to high school! That the purpose we have been discussing is fast becoming the teaching purpose of science at the present time, no one who has followed closely the trend of recent educational thought can seriously doubt. And if this is so, a large and interesting array of definite problems that can be answered only by experiment presents itself. The main question now is not—Has he gained a comprehensive view? but—Has he acquired a certain power? It is no longer—What does he know? but—What can he do? No longer—How much can he reproduce? but—How well can he produce?

We already have some data concerning the way the present system of teaching is serving this second purpose. Such data are obtained by setting original problems on examination or in the laboratory. And here again such data as I have collected have led me to the belief that none of us are succeeding over well at this. Nor need we expect to succeed so long as we follow mainly the didactic methods that have been found useful in other kinds of work. Power in solving problems is acquired only by solving problems under the spur of an inner motive of wonder, not by listlessly listening to a description of how some one else has solved them.

We have here a wide and important field for educational research. We know comparatively little about the most efficient means of developing power of solving problems. Mighty few of our texts treat the subject with a questioning attitude or in a way to develop this in the pupil. Open any text at random and read the heading of a new paragraph. Thus:

> In 1686 Sir Isaac Newton formulated three statements which embody the results of universal observation and experiment on the relations which exist between force and motion. The statement of the first law is, etc. A machine is a contrivance for the transference of energy, or both the transference and transformation of energy at the same time; it is therefore an instrument for doing work. It is an accepted belief among men of science that all space is filled with something so rare and subtle that it can not be weighed or indeed perceived by any of our senses, and to this all-pervading medium the name of *ether* has been given. (This last is the first sentence in the subject of light.)

Surely such treatment does not tend to develop power of solving problems in the pupils. But fortunately the teachers do not always follow the text: some let the text follow them. When this is the case, much may be done toward developing power of solving problems and initiative among the pupils. Yet such cases are the exception rather than the rule. Each of us can, however, find out how to do it if only he will recognize the fact that his daily task is a daily problem, requiring study and experiment for its solution, and then attack that problem resolutely and continue experimenting and carefully testing results until they are satisfactory.

In order to summarize the distinction I have been trying to make in the last few pages, let me again quote from Professor Wead's bulletin:

> If the thing to be aimed at is to make them pass a good examination as soon as the subject is read, the best means will be to put a text-book into the hands of every one, and require certain parts of it to be learned, and to illustrate them

in an experimental lecture with explanations. The lecture may be made very clear and good; and this will be an attractive and not difficult method of teaching, and will meet most of the requirements. It fails, however, in one. The boy is helped over all the difficulties; he is never brought face to face with nature and her problems; what cost the world centuries of thought is told him in a minute; his attention, clearness of understanding, and memory are all exercised; but the one power which the study of physical science ought preeminently to exercise, and almost to create, the power of bringing the mind into contact with facts, of seizing their relations, of eliminating the irrelevant by experiment and comparison, of groping after ideas and testing them in their adequacy, in a word of exercising all the active faculties which are required for an investigation in any matter—these may lie dormant in the class while the most learned lecturer experiments with facility and explains with clearness.

In what has been said I have dealt only with the most evident of the problems now before the physics teachers—namely, the problem of how to teach so as to leave the pupil with an added power to achieve. I have given it as my frank opinion that we are not oversuccessful in this at present, have urged that scientific experiment in teaching offers the only means of finding out how to become more successful, and have suggested several working hypotheses as possible guides to such experimenting. The subject has, however, only been grazed by what has been said. No mention has been made of the contributions that physics teaching might make to the social efficiency of the community; nor has the problem of making the physics contribute its share to moral education been considered. The questions as to why America does not contribute her just quota to the number of the world's greatest scientists have not been discussed. These larger problems of science will have to be left for future discussion. Their solution, like that of the problem that has occupied our attention, is waiting for the scientific experiments in education, which alone can lead us to a satisfactory conclusion.

C. R. MANN

THE UNIVERSITY OF CHICAGO

THE EIGHTH ZOOLOGICAL CONGRESS

THE preliminary announcement of the eighth International Zoological Congress is just issued and of it we make the following abstract. The congress meets at Graz, Austria, on August 15–20, 1910, under the presidency of Hofrat, Professor Ludwig von Graff, who was elected to the position at the Boston Congress in 1907.

At 9 A.M., on Monday, is the registration, followed by a meeting of the permanent committee of the congress and an inspection of the university. At 3 P.M. are the general formalities of opening, with addresses of welcome, presentation of delegates, formation of sections and the like. At the close of the session the members go to the Heimwald, where there will be an informal gathering in the restaurant.

On Tuesday and the following days the general sessions are at 9, with sectional meetings at 2 in the afternoons, and on Tuesday and Wednesday there are lantern lectures on Styria and the Dalmatian coast. From 4:30 on there are small excursions to the beautiful places in the surrounding mountains. On Friday evening the congress proper ends with a banquet to the congress.

On Saturday the congress goes on an excursion to the Erzberg and Leopoldstein See and on Sunday to Trieste, where the Austrian Zoological Station forms the chief object of interest. If possible the beautiful Imperial Castle of Miramar (associated in the minds of Americans with the unfortunate Maximilian of Mexico) will be visited.

From Monday, August 22, to Saturday evening, there will be an excursion in one of the steamers of the Austrian Lloyds down the Dalmatian coast, stopping at Rovigno, Pola, Sebenico, Traú, Spoleto, Lesina, Lissa, Meleda, Ragusa and Cattaro. Ample time will be allowed at the latter place for a trip

to the mountain town of Cettinje, the capital of Montenegro. On this trip the party will have meals and will sleep on the steamer. The cost is estimated at about 200 kronen, about $40, but this may be reduced, provided sufficient numbers take the excursion. Definite responses concerning it must be in the hands of the committee by June 1, next.

There is also offered a supplementary excursion which is most attractive to those who enjoy the out of the way. It leaves the other on the return trip at Ragusa, and goes into the mountains by rail to Mostar, the capital of Bosnia, and then to Sarajevo, the capital of Herzegovina, and thence to the end of the railway at Jaice. Then comes a carriage ride of about thirty or forty miles to the railroad at Banjaluka, where the train is taken again for Agram, the end of the excursion. On this trip there will be many stops, but the names of the stations mean little to most Americans. This supplementary excursion will occupy a week and the cost will be about $40 additional. It will be under the charge of the Bosnian-Herzegovinan Landes-Museum, thus guaranteeing the best of introduction to the strange lands of the Balkans.

Anyone interested in zoology is eligible to membership in the congress, the cost being 25 kronen (about $5.00). The wives and daughters of members may join as participants. Members have all the rights usually associated with membership (the fee being 12 kr.), and are to receive the publications of the congress. None but members and participants are entitled to attend the meetings of the congress or to take part in the excursions.

A second circular, giving full particulars of the sections, a list of hotels and boarding houses and other information will be issued in March, and this with the present circular will be mailed to all who request it. All communications should be addressed to the Praesidium des VIII. Internationalen Zoologenkongress, Universitätsplatz, 2, Graz, Austria. Postal orders or drafts for membership fees should be drawn in favor of the "VIII. International Zoological Congress" and be sent to the Steiermärkische Escomptebank at Graz.

Titles of all papers to be presented to the congress must be received before August 1, 1910, in order to have a place on the program; and as soon as the paper is read the manuscript must be handed to the secretary in complete shape, ready for printing.

THE DEPARTMENT OF AGRICULTURAL EDUCATION OF THE UNIVERSITY OF WISCONSIN

Professor Karl Hatch, who has charge of the newly organized department of agricultural education in the University of Wisconsin College of Agriculture, is formulating plans for assisting rural and high schools in their efforts to give effective instruction in agriculture. A traveling library of lantern slides illustrating various phases of dairying and farming has been provided which will be sent to schools for use. A collection of enlarged photographs of agricultural products and materials has also been prepared. An explanation of the methods of using the bulletins issued by the Experiment Station and the U. S. Department of Agriculture has also been provided, which is designed to make available for instruction the material in these official publications. The college of agriculture has arranged to have a number of its faculty deliver special lectures on teaching agriculture at county teachers' institutes.

A special annual appropriation of $30,000 for agricultural extension work, made by the last state legislature, has resulted in the expansion of this work until it now includes eleven different branches. The extension work in the department of horticulture includes demonstrations of the spraying of potato fields and of orchards, the distribution of pure-bred tobacco seed, the inspection of orchards and nurseries for destructive insects and fungous growths and assistance in landscape gardening.

Means of control and eradication of weeds are given through the agronomy department, which also disseminates pure-bred grains and seeds of forage plants among the farmers, in-

spects the seed sold by dealers to detect the seeds of noxious weeds and other foreign matter, conducts corn contests for young people, and cooperates with the farms of state and county institutions in demonstrating to the farmers of the neighborhood the best methods of handling their crops, from seeding to harvesting. For a state so recently redeemed from forest to agricultural use, the stump removal investigations of the extension department are of importance, as are also the lines of work in cranberry culture for the marsh districts, the extension farmers' courses, held for several days at a time in communities remote from the college, often in connection with homemakers' conferences under the auspices of the home economics department.

The department of agricultural economics has begun an investigation of the cost of farm products through a system of blanks to be filled out daily by farmers in typical portions of the state and tabulated at the close of the year by the department in cooperation with the U. S. Department of Agriculture. An employment bureau for graduates and former students of the college is also maintained by the department of agricultural economics through which farmers, dairymen and stock raisers can secure the services of young men especially trained for the branch of work for which they are desired.

Plans for the construction of farm buildings are prepared by the department of agricultural engineering, while the soils department promotes the reclamation of waste swamps through the organization of drainage districts, tests soils to find what form of fertilizer they need and advises as to crop-rotation to renew exhausted wheat lands. An improvement in the breeds of horses raised in Wisconsin has resulted from the stallion licensing system of the department of horse breeding, as improvement in other kinds of farm stock has come from the work of the animal husbandry department in forming dairy cattle breeders' associations, sheep and swine breeding societies and live stock judging contests.

Cooperating with the State Live Stock Sanitary Board and the State Veterinarian, the department of agricultural bacteriology investigates outbreaks of animal diseases with a view to control and elimination, as well as the causes of bad water supplies for villages and cities. The post-mortem tuberculosis demonstrations of the department at county and state fairs and other meetings have been a means of education to thousands of people as to the serious nature of the disease and the necessity and means of prevention.

Improvement in dairying through the distribution of starters for the making of butter and cheese, the testing of milk and cream, and monthly exhibitions at the dairy school where butter and cheese is scored as to its merits and defects has been an accomplished aim of the dairying department of the extension service, while the chemistry department has also assisted in this work through its tests of dairy cows as to production, to help farmers to weed out the poor producers. The inspection of feeds and fertilizers according to recent license laws has protected the farmers from the harmful ingredients often found in such commercial products before the department undertook the work. These means employed by the Agricultural College are aimed toward reaching the 200,000 farmers of the state with the results of the scientific investigations of the college and experiment station laboratories.

THE GEORGE WASHINGTON MEMORIAL BUILDING

We are requested to print the following letter calling the attention of members of the American Association for the Advancement of Science to the plan for the construction and endowment of a building in Washington to be used as headquarters for our national scientific organizations:

Washington, D. C.,
June 1, 1909.

Dr. L. O. Howard,
Permanent Secretary, A. A. A. S.

Dear Sir: I take great pleasure in bringing to your attention the project of the "George Washi gton Memorial Association" for the erection of

a building in the City of Washington to be known as the George Washington Memorial Building in commemoration of our first president and his interest in science and higher education in America.

At the present time there are no suitable facilities for bringing together at Washington the national patriotic, scientific, educational, literary and art activities. The association proposes to secure funds necessary for the erection of a building, well located, attractive in appearance, practical in plan and construction, and of the most durable character. It is to be planned so as to furnish a home and gathering place for national patriotic, scientific, educational, literary and art organizations that may need such accommodations, including the Washington Academy of Sciences and its sixteen affiliated societies. It will furnish a place where all the patriotic societies, both north and south, may testify to their love for the father of this country. The building will contain a great hall, or auditorium, and rooms for large congresses, such as the recent Tuberculosis Congress; rooms for small and large meetings; office rooms and students' research rooms.

In addition to the Memorial Building it is intended to secure an endowment adequate for its maintenance.

The advantages of a permanent home for the American Association for the Advancement of Science are too obvious to require further comment. The project has received the endorsement of the National Academy of Sciences, the Washington Academy of Sciences and its affiliated societies, the Association of Physicians and Surgeons, the National Association for the Study and Prevention of Tuberculosis and other national scientific and art organizations.

The George Washington Memorial Association is conducting an active campaign and is meeting with gratifying success in its efforts to obtain subscriptions.

To the scientific organizations of this country, and to our association, which is in need of a permanent home, such a building has an especial value, and members are urgently requested to cooperate in securing contributions.

While large subscriptions are desirable, I invite your favorable consideration to the following extracts from the appeal for the building fund.

This building must be the nation's tribute to Washington. Every one of us must have a part in it. I ask you to contribute one dollar each to this building, and in this way we will accomplish a most patriotic purpose and also have provided for carrying out in the highest sense the great thought of Washington, which as yet has not been recognized by the American people in any concrete form. A receipt with engraved head of Washington will be sent to each contributor and the name and address of each contributor will be entered in the permanent record of this great undertaking. The entrance fee shall be five dollars, which will cover the dues for the first year, to be remitted to the treasurer. The annual dues shall be two dollars, payable on or before the thirtieth day of January.

SUSAN WHITNEY DIMOCK,
President George Washington Memorial Association

It affords me great pleasure to second this appeal, and to request that you mail your contributions to Dr. L. O. Howard, Smithsonian Institution, Washington, D. C., so that in due time they may be transmitted as the offering of the members of the American Association for the Advancement of Science to a great and worthy cause.

Very respectfully yours,
DAVID STARR JORDAN,
President A. A. A. S.

SCIENTIFIC NOTES AND NEWS

As has already been noted the Royal Society has this year awarded its Copley medal to Dr. G. W. Hill, For.Mem.R.S., for his researches in mathematical astronomy; other awards are royal medals to Professor A. E. Love, F.R.S., for his researches in the theory of elasticity and cognate subjects and to Major Ronald Ross, F.R.S., for his researches in connection with malaria; the Davy medal to Sir James Dewar, F.R.S., for his researches at low temperatures, and the Hughes medal to Dr. R. T. Glazebrook, F.R.S., for his researches on electrical standards.

THE honors awarded on the occasion of King Edward's birthday include the following: Privy councillor, Sir Henry Roscoe, F.R.S.; knights, Professor W. A. Tilden, F.R.S., professor of chemistry and dean of the Royal College of Science, London, and Mr. E. H. Shackleton, the leader of the recent antarctic expedition. Professor A. H. Church, F.R.S., professor of chemistry in the Royal Academy of Arts, has been appointed a knight commander of the Royal Victorian Order (K.C.V.O.). Mr. T. L. Heath, Sc.D.,

principal clerk of the treasury, has been promoted to be knight commander of the Bath (K.C.B.), and Dr. Sven Hedin has been appointed an honorary knight commander of the Indian Empire (K.C.I.E.).

Professor L. A. Wait, head of the department of mathematics at Cornell University, where he has been professor since 1870, will retire from active service at the close of the present year.

Dr. Ernst Wilhelm Ebermayer, professor of agricultural chemistry at Munich, has celebrated his eightieth birthday.

Professor William Bateson has been elected president of the Cambridge Philosophical Society.

Sir William Noven, K.C.B., F.R.S., has been elected president of the London Mathematical Society.

Dr. M. P. Ravenel, professor of bacteriology at the University of Wisconsin, has been appointed "Official Rapporteur" to the International American Congress at Buenos Ayres next May, where he will have charge of the program devoted to tuberculosis.

Sir T. H. Holland, F.R.S., professor of geology and mineralogy in Manchester University, will deliver the Wilde lecture of the Manchester Literary and Philosophical Society for 1910.

The Rev. T. G. Bonney, F.R.S., delivered a lecture in Cambridge on November 25, on "A Desert Phase in the Development of Britain." Dr. H. H. W. Pearson, of Gonville and Caius College, professor of botany in the South African College, Cape Town, delivered a lecture, on November 19, on "A Botanical Journey in Southwest Africa."

An oil portrait of the late John T. Duffield, for many years professor of mathematics at Princeton University, has been added to the collection in Nassau Hall.

At the opening meeting of the Institution of Electrical Engineers, London, on November 11, a marble bust, by Mr. Hamo Thornycroft, of the late Dr. John Hopkinson, F.R.S., past-president of the institution, was presented to the institution by Professor Bertram Hopkinson on behalf of his mother, Mrs. John Hopkinson.

Dr. William James Russell, F.R.S., formerly lecturer in chemistry in the Medical School of St. Bartholomew's Hospital, died on November 12, at the age of eighty years.

The death is also announced of Dr. C. G. Graham, formerly professor of chemical technology at University College, London, at the age of seventy-four years.

Dr. John S. Coulter, professor of botany in the University of Chicago, gave recently an address before the Science Club of the University of Wisconsin, held to celebrate the hundredth anniversary of Darwin's birth.

President Charles R. Van Hise, of the University of Wisconsin, recently addressed the members of the honorary agricultural society at Iowa College, Ames, Ia., on "The Conservation of Our Natural Resources," and the St. Louis Academy of Science and St. Louis Pedagogical Society, in joint session, on the same subject.

Professor Richard E. Dodge, of Teachers College, Columbia University, gave an illustrated lecture on "Desert Life" before the geological department and the faculty of Colgate University on November 22. This was the first of a series to be given during the winter; the other lecturers being Professor W. M. Davis, of Harvard University, Professor James F. Kemp, of Columbia University, and Mr. Cyrus C. Adams, of the American Geographical Society.

The fifth course of lectures by the Harvey Society, to be given in the New York Academy of Medicine on Saturday evenings, includes the following:

December 4—Professor Otto Cohnheim, University of Heidelberg, "The Influence of Sensory Impressions on Scientific Deductions."

December 11—Professor T. G. Brodie, University of Toronto, "Renal Activity."

December 18—Professor Carl G. Huber, University of Michigan, "Renal Structure."

January 15—Professor Ludwig Hektoen, University of Chicago, "Certain Phases of the Formation of Antibodies."

February 19—Dr. Eugene L. Opie, The Rockefeller Institute, "Inflammation."

March 5—Professor Adolf Meyer, Johns Hopkins University, "The Present Status of Aphasia and its relation to Psychopathology."

March 19—Professor A. Magnus-Levy, University of Berlin, "Pathology and Therapy in Diseases of Metabolism."

THE International Committee for the Study of Methods of Control of Bovine Tuberculosis will hold its first meeting at Buffalo on December 13.

THE German National Museum at Munich has asked Dr. Lowell, director of the Lowell Observatory, for records of the observatory's work for their archives and permanent exhibition, comprising: (1) A series of photographs of Mars; (2) photographs of Jupiter; (3) spectra of Mars showing water vapor and comparison spectra; (4) spectra of the other planets; (5) the characteristic star spectra exhibited at Dresden last summer by Mr. Slipher.

THE annual exhibition of apparatus by the Physical Society of London will be held on December 14, when the exhibition will be open from 3 to 6 in the afternoon and from 7 to 10 in the evening.

THE chancellor of the University of Kansas is the state sealer of weights and measures, and Chancellor Strong has just caused to be mailed to the county officers concerned and others interested, copies of a bulletin on Kansas Weights and Measures. This bulletin gives specifications for town, city and county standards, and instructions to sealers and inspectors, and also the laws of Kansas relating to weights and measures. In the introduction to the bulletin, the chancellor says that "Though not at present fully recognized, the sealer of weights and measures should be one of the most important public officials in his community."

UNIVERSITY AND EDUCATIONAL NEWS

THE Catholic University of Washington will receive $120,100 by the will of Mrs. Emily Lusby, of Baltimore.

THE *Educational Times* states that the committee appointed by the British chancellor of the exchequer to consider the apportionment of the £15,000 additional grants which he proposes to give to the University of Wales and its three constituent colleges have recommended the following allocation, viz., £1,500 per annum to the university for fellowships in arts and sciences; £1,500 a year to the Cardiff Medical School; £4,000 each to the colleges at Bangor, Aberystwyth, and Cardiff to provide increased salaries to the staffs, further equipment for libraries and museums and provision for tutorial assistance; and £500 each towards establishing a pension scheme.

THE University of Glasgow has received, from Miss Pollock and Mrs. Gilchrist, sisters of the late Dr. Robert Pollock, notice that they intend, in accordance with their brother's wishes, to bequeath to the university £10,000 for the foundation of a lectureship in materia medica for the encouragement of research.

DR. WILLIAM DEY, for many years a member of the University Court, Aberdeen, and his brothers have given £2,500 to the university to found a scholarship in education in memory of their father.

A SYNDICATE has been appointed at Cambridge University to consider the question of providing pensions for professors and others in the service of the university.

DR. J. S. SHEARER has been promoted to a professorship in physics at Cornell University.

MR. EDGAR I. WENGER, associate in railway engineering at the University of Illinois, has been appointed assistant professor of electrical engineering at McGill University.

AT the University of North Dakota A. H. Taylor, Ph.D. (Göttenberg) has been appointed head of the department of physics, vice G. W. Stewart, Ph.D., now of the University of Iowa, and H. E. Simpson, M.A. (Harvard), formerly professor of geology in Colby College, assistant professor of geology. J. E. Rhodes, M.E. (Clemson), has been appointed instructor in mechanical drawing; Alfred A. McAlister, M.E. (Ohio State), instructor in mining and electrical engineering;

H. W. Daudt, M.S. (Harvard), assistant in chemistry, and Miss Florence Balch, M.A. (Columbia), instructor in mathematics.

THE following appointments have been made in the School of Mining, Kingston, Ont.: M. B. Baker, B.A., B.Sc., advanced from lecturer to professor of geology; Leo F. Guttmann, Ph.D., assistant professor of chemistry; R. J. Manning, M.A., lecturer on chemistry; W. D. Bonner, M.A., lecturer on chemistry; J. Robertson, M.A., lecturer on physics; G. H. Herriot, B.Sc., lecturer on mathematics; S. N. Graham, B.A., B.Sc., lecturer on mineralogy; J. A. McCrae, M.A., M. L. Hersey fellow in chemistry; B. Rose, B.Sc., assistant in mineralogy; B. E. Norrish, B.Sc., assistant in drawing.

THE council of King's College, London, have appointed Dr. David Waterston as professor of anatomy, in succession to Professor Peter Thompson, appointed professor of anatomy in Birmingham University. Dr. Waterston was lecturer in anatomy in the University of Edinburgh. Dr. George C. Low has been elected lecturer in parasitology and medical entomology.

MR. W. S. ABELL, instructor in naval architecture at the Royal Naval College, Greenwich, has been appointed to the chair of naval architecture in Liverpool University, endowed by Mr. Alexander Elder.

DR. E. VON TSCHERMAK has been appointed professor at the Hochschüle für Bodenkultur, Vienna.

DISCUSSION AND CORRESPONDENCE

THE EFFECTS OF RAPID AND PROLONGED DEEP BREATHING

THE following results of simple experiments may be of sufficient general interest to warrant publication in the columns of SCIENCE. They are in no sense new, but are described by way of emphasizing important facts which have been generally neglected and not with any pretense to originality.

The experimental results to which I refer show the effect of enforced deep breathing over a period of several minutes on various functions of the human body. These effects are of several kinds and a few of the simpler ones may be summed up as follows: (1) material increase in the length of time the system can do without respiration; (2) effective mental stimulant; (3) material increase in physical endurance for a short time; (4) rise in the frequency of pulse beat.

1. It has been noticed by others that deep violent breathing for several minutes so changes the system as to make respiration unnecessary for perhaps as much as five minutes after this preparatory breathing is over. In my own case I have found that four minutes' enforced breathing makes it possible to hold the breath for three minutes and a half, whereas without this preparation 56 seconds was my limit. The time during which it is possible to do without respiration increases, of course, with the length of time during which the preparatory breathing is carried on. The increase does not go on indefinitely, but reaches a definite limit, beyond which further length of time given to preparatory breathing does not increase the time during which the breath may be held. Below is a table taken from a curve which represents experiments on myself. The limit (3 minutes 34 seconds)

(*a*) Length of time in minutes devoted to deep breathing.

(*b*) Time in minutes and seconds during which the breath may be held after preliminary breathing is stopped.

(*a*)	0	¼	½	¾	1	2	3	4
(*b*)	0.56	1.24	1.39	1.54	2.12	3.00	3.26	3.34

which is indicated in this table would doubtless differ with different people. It should be noticed that the preparatory breathing is effective long after the "washing out" of the lungs must have been completed. The change produced in the system is certainly, therefore, more fundamental than a lung change, and would appear to a layman to indicate a temporary change in blood constitution.

2. The effect as a mental stimulant is very pronounced. I have noticed in my own case that mental fatigue may be postponed, far beyond the usual point, by two minutes of

rapid deep breathing at half-hour intervals. A feeling of sluggishness or sleepiness may be almost completely dispelled. I have never noticed any reaction as in the case of most stimulants and altogether it seems to me very satisfactory.

3. The effect on muscular fatigue is also striking. A difficult arm exercise with heavy weights which I could not repeat under ordinary circumstances more than twenty times, I found after four minutes of this preparatory breathing that I could do twenty-seven times, *i. e.*, about thirty per cent. more. This increase I found to exist at all stages of fatigue, as might be expected.

4. The pulse beat goes up very rapidly while the breathing is continued, in my own case from about 65 to 106 after four minutes' breathing.

Another curious effect which perhaps is worth mentioning is the apparent rapid lapse of time during the latter half of a hard breathing period. This change in the time-sense is very noticeable.

I might add, in conection with paragraph one, that a friend of mine has found a five-minute limit to the time during which he is able to hold his breath after the preliminary breathing.

I should not have ventured to describe phenomena which are so easily in the reach of every one, had I not found in people at large, and even among scientific men, a surprising ignorance as to their existence. I have seen some very amusing betting on how long it was possible to hold the breath, and have seen the cock-sure bettor laid low by not knowing of this possible resource of his adversary.

As a mental stimulant, and as a means to increase the time during which the system can do without respiration, violent breathing might find considerable useful application, and daring rescues from suffocation are common enough to make a knowledge of this possible threefold endurance without air of no little value.

D. F. COMSTOCK

MASSACHUSETTS INSTITUTE OF TECHNOLOGY,
November 3, 1909

ESPERANTO

MR. J. D. HAILMAN's interesting letter on the use of Esperanto by scientific men[1] is, I venture to think, somewhat misleading. He says (p. 561):

> This solution is the world-wide adoption of an *international* language—a second language which all will learn in addition to their natural tongue. . . .

The chemist, in order to be moderately well equipped, requires a good reading knowledge of English, French and German. Suppose we take a somewhat extreme case and assume that after January 1, 1910, under penalty of instant death, all chemical communications must be made in Esperanto, what would be the effect? Apart from the possible creation of a few desirable vacancies, the only result of such a law would be that chemists would have to know at least *four* or *five* languages, including Esperanto, instead of *three* or *four*, as at present. The reason for this is, of course, that the greater portion of the facts and theories which constitute chemistry has been contributed, hitherto, in English, French or German and, in many cases, it is absolutely necessary to have an author's original words.

The same conditions doubtless apply, *mutatis mutandis*, to other branches of knowledge.

I have no desire to obtrude an opinion regarding the merits and defects of Esperanto, nor to say anything as to the desirability or otherwise of an international language. I believe, however, that it is timely to point out that the adoption of Esperanto will involve an increase to the weight of languages which the scientific worker has to carry and that it will not be an alleviation of his burden. It is only fair to call upon the enthusiastic propagandists of Esperanto to state this fact clearly during their missionary labors.

J. BISHOP TINGLE

MCMASTER UNIVERSITY,
TORONTO, CANADA,
October 28, 1909

SCIENTIFIC BOOKS

Descendenz und Pathologie. Vergleichend-biologische Studien und Gedanken. By

[1] SCIENCE, October 22, 1909.

D. von Hansemann. Pp. 488; no illustrations. Berlin, A. Hirschwald. 1909.

There is considerable room for doubt whether the title of this fascinating volume was well chosen and whether a more correct title would not be "Evolution and a Pathologist" instead of "Evolution and Pathology." But, while there is little pathology, as such, the subject matter is presented by a master mind whose training has been in the field of abnormalities, and many a well-worn biological theme is clearly illustrated by facts from his own domain of science. In his introduction von Hansemann states that his book is for those who are familiar with the principles of evolution, but who have no far-reaching knowledge of pathology; and for those pathologists who have been so absorbed in pursuing their own goddess that they lack insight into the subject-matter of modern evolution. It would be expected, therefore, and the expectation is fully realized, that the essential points in the philosophy of evolution would be presented in the clear light of a well-trained mind and by one who views them somewhat objectively.

A vigorous supporter of Darwin, von Hansemann pays his respects to neo-vitalists by calling their philosophy pure speculation, and as such really less scientific in spirit than that of the old nature philosophers (p. 8), and throughout the book he returns again and again to the dicta of Darwin and of Weismann. The chapters on Preformation, Species and Varieties, Variability, Conditions of Constancy, Altruism, Design (Zweckmässigkeit) and Orthogenesis, Lamarckism, Functional Adaptation, Epidemics and Physiological Death, are devoted mainly to arguments in favor of the origin of variations. While much of this matter is old and many of the arguments somewhat hackneyed to a biologist, there is, nevertheless, a constant novelty in the ever-present point of view of the pathologist and a not inconsiderable originality in the interpretation of facts. Here, especially, are to be noted his views on variability, on altruism, on regeneration and transplantation, and on epidemics.

The key-note of his view on variations is sounded in the sentence "die ganze Fragestellung in Bezug auf die Entstehung der Variabilität eine unrichtige ist" (p. 150), and he takes the original ground that variability is one of the fundamental properties of living protoplasm and seeking for its origin, therefore, is lost effort. If a constant tendency to vary is a fundamental property of protoplasm, then the problem of the origin of species becomes more simple by the effort to ascertain what it is that gives or causes constancy of type. The chapter devoted to this phase of his subject (Bedingungen der Konstanz) is the most interesting one in the book and is worked out with the greatest argumentative ingenuity and with a wealth of illustrations and citations. Concerning variability he says:

Natürlich stelle ich mir diese innere Ursache nicht als irgend etwas Mystisches vor, das ausserhalb der mechanischen Erklärungsmöglichkeit liegt, sondern als eine der lebenden Materie inhärente physikalische Eigenschaft, die aus der besonderen Form der Vereinigung ihrer Atome und Moleküle erklärt werden muss und deswegen zur Definition der lebenden Substanz gehört (p. 152).

As a ball upon an inclined plane is prevented from rolling by some external hindrance, so species, having an inherent and continual tendency to vary, are prevented from changing by reason of external conditions. Adaptation means the establishing of an equilibrium between the internal forces and such external conditions. The statement of his principle is followed by a discussion of the many ways whereby constancy of type might be brought about, environmental and climatic changes, inheritance and other phenomena usually credited with bringing about variations, are here regarded as effective agents in checking the inherent tendency to vary, while in the highest types of living things, which presumably have passed through a long phylogenetic history of variations, this fundamental property has become weakened or partially lost, so that in such highest forms we find the greatest fixity of types.

The phenomena of regeneration, also, are

traced back to a fundamental property of protoplasm, and, like the capacity to vary, this property becomes more and more limited with advanced differentiation until, in the highest types of animals, the power of regeneration is much more reduced than in lower forms. This power, he thinks, still remains in the germ plasm which in higher animals becomes more and more localized in specific organs while in plants and in lower animals it is still present in part, at least, in all somatic cells, making them what Driesch calls "equipotential." Not only in different animal types does this somatic and germinal distinction exist, but among the different cells of the same individual as well, the difference being measured by their relative power to regenerate, from which it follows that "the regenerative power of a cell-type is a criterion of its differentiation" (p. 44).

The expression "struggle for existence," as used in current theories, he regards as an erroneous phrase for the description of natural phenomena. The conditions throughout all nature, he thinks, indicate a "compromise" of individuals bound by the fundamental law of altruism which is as strikingly operative between varieties, species and races as it is between the various organs, tissues and cells of the individual.

Manche Lebewesen stehen in so enger altruistischer Beziehung zueinander, dass sie bei künstlicher Aufhebung derselben zu Grunde gehen. Bei anderen ist dieser Verhältnis ein viel locheres, ja viele Arten stehen so weit auseinander, dass die altruistischen Beziehungen zwischen ihnen garnicht mehr erkannt werden können. Man kann mit Sicherheit behaupten, dass überall, wo diese Beziehungen enge sind, eine Abhängigkeit in der phylogenetischen Entwicklung bestanden hat. Ganz besonders deutlich tritt das bei Anpassung von Instinkten zweier Tiere in die Erscheinung, z. B. bei der Symbiose des Einsiedlerkrebses und der Aktinie, und man ersieht daraus, dass diese längst anerkannte und auch schon von Darwin hervorgehobene Tatsache sich aus den Erscheinungen des Altruismus ausreichend erklärt (p. 225).

Bearing the title it does, one naturally looks under the heading "Epidemics" for something more akin to pathology than the other chapters present. But a zoologist would have little use for the medical information to be gathered here. The term "epidemic" is used in its broadest sense and not at all with the usual significance. In using it biologically, he differs widely from Osborn and others who have made use of the term in a pathological sense and in connection with disease as one of the factors in the extinction of animals of the past and present. Von Hansemann uses the term to indicate an abnormal or unusual increase of numbers of a race or species of animals; he would not speak of an epidemic of typhoid fever but would describe such a wide-spread illness as due to an epidemic of *Bacillus typhosus*. Great collections of fossils of one type in one geologic bed similarly would be "epidemics." The reason for such epidemics might be unusual abundance of food or unusual absence of adverse environmental conditions, such as absence of enemies or, in a pathological sense, absence of protective agents on the part of the host. Such epidemics, he argues (p. 459), would be another means of increasing varieties and species through variation, since increase in numbers means proportional increase in the number of variants.

The limits of a review do not permit of an enumeration of the hundreds of other interesting points that are brought out with delightful clearness and fairness of presentation. Many of his conclusions are, indeed, open to question, especially such as result from a too superficial view of the problem concerned, but these are due more to ignorance of the great mass of facts involved than to faulty logic. Taken as a whole the book is full of valuable suggestions and is an undoubted contribution to the philosophy of evolution, and as such will be gratefully received.

GARY N. CALKINS
COLUMBIA UNIVERSITY

Cave Vertebrates of America—A Study of Degenerative Evolution. By CARL H. EIGENMANN, Professor of Zoology, Indiana University. 241 pages, 31 full-page plates and 72 text figures. Carnegie Institution of Washington. June, 1909.

Dr. Eigenmann has combined in this one work the results of his various papers on the cave vertebrates of America. The title is slightly misleading, as he includes blind vertebrates which do not inhabit caves. He also includes the results of others who have been interested in the study of blind vertebrates. It is a very comprehensive work dealing with species distributed over the greater part of the United States from the Pacific to the Atlantic and as far south as Cuba, the West Indies and northern portion of South America.

The main bulk of the work is upon the eye as affected by the absence of light. However, he devotes considerable space to morphological, zoological and physiological points of interest in connection with the animals studied. The other special senses were experimented upon and studied in some detail. The embryology of some forms was studied with special reference to the development of the eye.

After a short introduction he devotes considerable space to a general consideration of caves and cave fauna. In this he deals with the relation of caves to the rest of the universe; the environment of caves; the origin and distribution of cave animals; the food supply; the relation of the age of caves to the variety of cave fauna; the tendency to divergence in epigean fishes and convergence in cave forms.

As to the origin of cave fauna, he holds that only those forms which are negatively heliotropic or positively stereotropic are able to adapt themselves to cave life; that species depending on sight for procuring food can not adapt themselves to the environment of the cave. The cave fauna is not the result of accidental entrance of epigean forms. The aquatic cave fauna has developed from those forms adapted to live in dark and secluded places following the stream as it has gradually through ages formed subterranean channels. The non-aquatic forms are of more recent origin and have migrated into the caves after their formation. These are gradually adapting themselves to the more remote parts of the caves.

The author then takes up in detail the blind and cave vertebrates and their eyes. This comprises the main part of the work, consisting of 210 pages illustrated by 29 full-page plates and 72 text figures. Although, with the exception of birds, all classes of vertebrates are represented by species having degenerate eyes, by far the greatest number is found in fishes and fish-like vertebrates.

Only two species of mammals are described —the common mole and the cave rat. The former has very degenerate eyes, while in the latter the eyes are practically normal and resemble very closely those of the common gray rat.

Of the amphibians only four species of salamanders are described as inhabiting caves. Three are from the caves of the Mississippi valley, the fourth is from the underground streams near San Marcos, Texas. Detailed descriptions of these eyes are given.

Three reptiles are described: *Amphisbæna punctata,* a blind legless lizard from Cuba; *Rhineura floridana,* a legless burrowing lizard from Florida; and *Typhlops lumbricalis,* a blind snake found generally distributed in the West Indies and Guiana.

After a brief description of the eye of a fish (*Zygonectes notatus*) having normal vision and closely related to the blind fishes, he begins a detailed description of the different species of blind fishes. Although special reference is given to the eye, he treats of such general topics as general habits, respiration, reactions to light, tactile organs, the ear, anatomy of different organs, reproduction, etc.

He describes the development of *Amblyopsis* from the egg, being successful in rearing one to the age of ten months. He corrects the erroneous idea that *Amblyopsis* is viviparous. The mother deposits the eggs in the gill clefts, where they are retained during development till the young reach a length of about 10 mm. and the yolk is mostly absorbed.

Tactile organs are extremely well developed and these take the place of the lost visual sense. The ear is normal. In regard to their power of hearing, he says:

. . . if we define hearing to be the sensation

received through the ear and caused by vibrations either in the air or water, the experiments cited do not enable one to conclude definitely whether the blind fishes hear or not. If they do hear, their power in this direction is very limited.

Twelve species of blind fishes are dealt with. One, *Typhlogobius californiensis*, found under the rocks at Point Loma, near San Diego, Cal., has normal eyes when young, but degenerate in the adult. Another, a blind catfish (*Amieurus nigrilabris*) from Pennsylvania, is briefly described by Cope. The remaining ten species of blind fishes were procured from the caves of central and southwestern United States and from Cuba. Eight of these belonging to the Amblyopsidæ ("blind fishes") inhabit North America. The other two, members of the Brotulidæ, were secured in the caves of Cuba.

Of the Amblyopsidæ three species of *Chologaster* (*cornutus, papalliferus* and *agassizii*) have well-developed eyes. The other species of Amblyopsidæ, *Amblyopsis spelœus, Troglichthys rosæ, Typhlichthys subterraneus, Typhlichthys osborni* and *Typhlichthys wyandotte,* have only vestigial eyes.

The two Cuban species, *Stygicola* and *Lucifuga,* were both found to be viviparous. No definite breeding season could be determined, as females with young were found at various times throughout the year. "The eye decreases in size progressively from birth to extreme old age concomitantly with the appearance of masses of pigment cells in the orbital fat." Shriveling may occur in one eye of an individual while the other may show a massing of pigment cells. All structures connected with the eye show this progressive reduction from birth to old age.

The closing chapter discusses the causes of individual and phyletic degeneration. The following views of others concerning the cause of degeneration are discussed: (1) Organs diminish with disuse (Lamarck, Roux, Packard); (2) through a condition of panmixia a reduction occurs (Romanes, Lankester, Morgan, Weismann); (3) natural selection (Darwin, Romanes); (4) struggle of organs for room and food (Roux, St. Hilair); (5) the struggle between soma and germ for greatest efficiency at least expense (Lendenfeld); (6) germinal selection (Weismann), (7) process of mutation.

The author's views of the causes of degeneration may best be given in his own words:

> The Lamarckian view, that through disuse the organ is diminished during the life of the individual, in part at least on account of the diminution of the amount of blood going to a resting organ, and that this effect is transmitted to succeeding generations, not only would theoretically account for unlimited progressive degeneration, but is the only view so far examined that does not in the face of it present serious objection. Is this theory applicable in detail to the conditions found in the Amblyopsidæ? Before going farther, objections may be raised against the universal assumption that the cessation of use and the consequent panmixia was a sudden process. This assumes that the caves were peopled by a catastrophe. But it is absolutely certain that the caves were not so peopled, that the cessation of use was gradual and the cessation of selection must also have been a gradual process. There must have been ever widening bounds within which the variation of the eye would not subject the possessor to elimination.
>
> *Chologaster* is in a stage of panmixia as far as the eye is concerned. It is true the eye is still functional, but that the fish can do without its use is evident by its general habit and by the fact that it sometimes lives in caves.
>
> The present conditions have apparently existed for many generations, as long as the present habits have existed, and yet the eye still maintains a higher degree of structure than reversed selection, if operative, would lead us to expect, and a lower degree than the birth mean of fishes depending on their eyes—the condition that the state of panmixia alone would lead us to expect. There is a staying quality about the eye with the degeneration, and this can only be explained by the degree of use to which the eye is subjected.

Three general conclusions may be added:

> (1) The bleached condition of animals living in the dark, and individual environmental adaptation, is transmissible and finally becomes hereditarily fixed. (2) Ornamental secondary sexual characters not being found in blind fishes are, when present, probably due to visual selection. (3) Individual degeneration of the eye may begin in even earlier stages of development until nearly

the entire development becomes affected, that is, functional adaptations are transmissible.

JAMES ROLLIN SLONAKER
LELAND STANFORD JUNIOR UNIVERSITY

Effects of the Rays of Radium on Plants. By CHARLES STUART GAGER. Memoirs of the New York Botanical Garden, Vol. IV., 1908. Imp. 8vo, viii + 278 pages, 73 figures and 14 plates. Price $2.00.

As known to several botanists, the author was engaged for some time in studying the effects of radioactivity on various plant processes. The present volume represents the sum and substance of approximately four years of labor and is presented as a pioneer investigation; comprehensive in scope and as offering initial suggestions for several important problems.

During the research period "standard preparations of the purest radium bromid yet obtained" were placed at the disposal of Dr. Gager by Mr. Hugo Lieber, of New York City. As a result of the cooperation of liberality and investigation we may now feel quite certain that the rays of radium constitute a stimulus to the metabolic processes in plants. In conformity with other stimuli, that of radioactivity exhibits a minimum, optimum and maximum. Metabolic processes in general, whether constructive or destructive, are accelerated by intensities of stimulation between the minimum and optimum, while greater intensities beyond the optimum retard until death follows at the maximum.

Looking more particularly at the individual topics treated, we find an initial chapter of fourteen pages which constitutes a digest of about one hundred and fifty citations. In clear and rather popular style the essential facts of the nature of radioactivity are presented.

The universal presence of radioactivity in soil, water, rain, snow, etc., is elaborately discussed and the obvious deduction drawn that living matter can hardly escape its influence. Such being the case, any sudden change in the intensity of the emanations would be expected to constitute a stimulus to the exposed organisms.

Quite appropriately some attention is given to the undemonstrated conclusions of various authors regarding radioactivity as a property of wood, flowers and other plant organs. The unsuccessful efforts to artificially create life through the influence of radium are explained. An historical review of previous work done on both plants and animals occupies several pages.

The power of radium to affect the germination of seeds and the subsequent growth of the seedlings is clearly shown by the author's own work. A given plant can be educated, so to speak, to endure an intensity of stimulus which on first exposure retarded growth. This shows that since radioactivity is so universal in nature that plants are probably naturally attuned to at least a low intensity which may be gradually increased without disturbing the normal processes in the plant. Freshly fallen rain may have sufficient radioactivity to retard growth of plant organs. The same may be true of tap-water previously exposed to the emanations of radium.

Alcoholic fermentation, and respiration, both aerobic and anaerobic, were found to respond to stimulus. On the other hand, tropistic responses were not with certainty demonstrated.

The profound influence of the rays of radium is manifest if we look at the abnormalities arising in the cells and tissues of plants exposed. Thus in the hypocotyls of beans, lupins, etc., retardation of growth was accompanied by a lack of coordination in histogenesis, stoppage of cell-division, acceleration of tissue-differentiation, decrease in size of the cells. In a given case any one or all of those effects may be found. Mitosis in any of its phases is likely to be profoundly modified with marked distortion of the mitotic figures and disturbance of the normal processes of nuclear division.

The attempts to induce mutation by radioactivity were not continued to success, though some intimations were obtained that it may be possible to do so.

The paper closes with an extended theoretical discussion of about seventeen pages.

From the facts included in this descriptive review it is evident that this work has a com-

prehensive value both to those who may be interested from the popular standpoint and to those who intend to work themselves. The bibliography includes about five hundred and sixty-five citations.

For valuable counsel during the earlier progress of the work the author makes acknowledgment to Professor Wm. J. Gies.

RAYMOND H. POND

BOTANICAL NOTES

THE EAR-ROTS OF INDIAN CORN

Two recent bulletins deal with this serious trouble to our most important crop. The first is "The Life-History and Parasitism of *Diplodia zeae* (Schw.) Lev.," by F. D. Heald, E. M. Wilcox and Venus W. Pool, in the Twenty-second Annual Report of the Nebraska Agricultural Experiment Station, January, 1909. This paper gives the results of the investigations which have been in progress for several years as to the cause of the extensive loss in Nebraska from ear-rots. The complete life-history of the fungus is worked out, the results of inoculations given and its distribution in the state shown. The illustrations are especially fine.

The second paper bears the title "Ear Rots of Corn," by Thomas J. Burrill and James T. Barret (Bull. No. 133, Ill. Agric. Exp. Sta., Feb., 1909). This a more extensive bulletin, largely upon the same subject as the earlier publication by the Nebraska Experiment Station, and is one which merits the careful reading of all plant pathologists, mycologists and others interested in the botanical or practical aspects of the subject. In Illinois the annual loss from ear rots is from two to four and a half per cent. of the entire crop, representing a money loss of from two to five and a half million dollars. This bulletin is the result of extensive investigations covering several years. Ninety per cent. of the rot was found to be due to *Diplodia zeae* (Schw.) Lev. The fungus was thoroughly studied in laboratory and field; inoculations were made to show the time and mode of infection; its round of life was carefully worked out, and means of prevention suggested.

Three species of *Fusarium* are largely responsible for the other rots. The characteristic rot of each species is described but work upon these forms is still incomplete.

MORE DARWIN LITERATURE

IT may be well to record here several addresses that have seen the light in various places in printed form:

"Darwin as a Naturalist: Darwin's Work on Cross Pollination in Plants," is the title of Dr. William Trelease's address before the Botanical Society of America last winter, and published in *The American Naturalist* for March, 1909. This is first a general estimate of Darwin as a student of plants, followed by an analysis of his contributions to our knowledge of the mechanism and meaning of cross pollination, including a list of his publications (twenty-two titles) on pollination and fertilization.

"Darwin and Botany" is the title of a short address given by Dr. N. L. Britton at the American Museum of Natural History on February 12 last, and published in the *Popular Science Monthly* for April, 1909. In this the writer traces the evolution of Darwin's contributions to botany, and declares that "the value of the impulse given by Darwin to botanical investigation in all its branches is beyond estimation."

Professor J. M. Macfarlane's first address, "Darwin in Relation to his own and the Pre-Darwinian Period," before the faculty and students of Pennsylvania College, February 12, is a summary review of the period preceding Darwin's work, and the steps by which the different phases of the doctrine of evolution have been attained. His second address, "Lessons from the Life and Writings of Charles Darwin," before the members of the Philadelphia Girls' High School, February 15 and 23, brings out Darwin's persistence in his work, his self-denial, his sweet spirit, free from envy or jealousy and his faith in the ultimate dominance of truth. His third address, "The Legacy Left us by Darwin and his Collaborators," before the Linnean Society, the faculty and students of Franklin and Marshall College, February 27, dwells upon

the evolution and transformation in thought that has been one of the greatest results from the work of the great naturalist. These three addresses have been brought together and privately printed, making a pretty 64-page pamphlet with the general title "Charles Darwin: Three Appreciations, by J. M. Macfarlane."

Here may be listed Dr. R. G. Eccles's "Parasitism and Natural Selection: A Medical Supplement to Darwin's Origin of Species," first published in the *Medical Record,* July 31, 1909, and now reprinted as a 34-page pamphlet. The author emphasizes the part taken by parasites in the evolution of organisms, not only in the present, but also in the remote past.

A NEW BOTANICAL HISTORY

Proofs have been received of the first part of Dr. E. L. Greene's "Landmarks of Botanical History," now in the press and soon to be published in the "Smithsonian Miscellaneous Collections." When completed the work will consist of three volumes, and judging from the pages we have examined it will be a most helpful and discriminating contribution to our knowledge of the development of the science. At the outset the author makes the rather startling statement that "What is here undertaken is not a history of botany." He has not planned to present "in chronological succession the long line of the contributors to the upbuilding of this science with an account of the best contributions each has made," but rather to touch here and there upon the work accomplished by botanists in the gradual development of botany from its earliest beginnings. In the phrase of to-day, he proposes "to touch the high points" in the history of botany.

Every botanist will await the publication of this book with great interest, for no man is better prepared by nature and education for this task than Dr. Greene. An early notice of the first completed volume will appear in these columns.

Charles E. Bessey

The University of Nebraska

AN INDUSTRIAL COMMISSION

Some recent developments in the relation of producers and manufacturers of cotton in the United States certainly call for a scientific study of the question with a view to devising some plans by which the elements entering into the cotton industry shall the more clearly understand the situation and be better understood by other factors of the industry.

At a recent meeting of the Georgia Industrial Association in Atlanta, Ga., the cotton mill owners of the state passed the following resolutions:

Resolved by the Georgia Industrial Association that, owing to the disparity between the cost price of cotton goods and yarns, based upon the present price of cotton, and the market price thereof, that it is necessary for the mills of this association, as a matter of self-protection, to inaugurate and enforce the curtailment of not less than 25 per cent. of their running time.

Resolved, further, that each mill of this association is instructed to make such curtailment not later than November 1, 1909, and continuing until January 1, 1910, and thereafter until the selling price of the finished product approximates its cost.

We further recommend that all the mills of this association decline all offers and withdraw all quotations upon finished product at a less price than the cost thereof, based upon the price of cotton at the time of sale.

It is a well-known fact that the cotton raisers of the south have long been trying to organize themselves, so that they would be able to have something to say about the price of cotton, and in view of the present high prices, they think that they have cause to rejoice at their efforts, and to believe that they have scored a victory. While the writer believes that the law of supply and demand will eventually regulate, it must be conceded that this misunderstanding is calculated to lead to serious results, if the cotton industry of the south and country fails to grasp its meaning.

The National Farmers' Union of America in answer to the above resolutions recently issued a statement through the public press that "curtailment of output by cotton mills

on account of high-priced cotton is a humorous bluff." This view is of course taken up by the farmer, who is not in a position to see the seriousness of the situation.

The American Cotton Manufacturers' Association issues in the *Textile Manufacturer* the following reply to President Barrett, of the Farmers' Union:

The recent utterance of President Barrett, of the Farmers' Union, and the editorials of the *Cotton Journal* are in bad taste, and show a surprising lack of grasp of the situation.

The cotton manufacturers of the south are interested in the development and welfare of the south and are big and broad enough to realize that a fair price for cotton means prosperity for this section.

The farmers are in the midst of prosperity while the mills are in distress. Both are linked together in the general prosperity of the south and the farmer should show his willingness to cooperate.

This relation between the two great factors of the cotton industry of the south grows a little more critical with each report that comes from either side without any possible means for either side to know the status—the real status—of the other. The writer is inclined to believe that such a matter is of national importance and should call for the best thought of the country. If these two great organizations, the producers, on the one hand, and manufacturers, on the other, could be made to more clearly understand the other by a National Industrial Commission or Arbitration Board, the country would be the gainer far out of proportion to the cost of maintaining the commission.

The mills concede that the price of cotton is not too high, yet they can not fail to see that such action as they have taken actually cost the farmers of the country right about $450,000 the tenth day after the meeting of the Industrial Association. Possibly the farmers should help bear the burden, but the real issue is this—the mills should not have the privilege of passing judgment on the matter for all concerned, which it virtually amounts to, since their action seems to vitally affect the price of cotton. The point uppermost in the mind of the writer is that all should help bear the burden, but let the matter be submitted to an arbitration commission, whose duty it shall be to investigate the cost of raising cotton, and the cost of manufacturing, and such report as they make annually, or oftener, be distributed among all people. The commission need not confine its work to any particular line of industry, but should turn its attention to all matters of national importance about which there is likely to arise a misunderstanding. This commission could well be considered a common resort for justice in proportion to its authority and influence.

When we contemplate the fact that Great Britain is developing cotton growing in all her colonies, and will sooner or later be in position to supply her own mills with the raw material, the matter assumes a new interest. A letter comes by this mail from the director of agriculture, Zomba, Nyasaland, British East Africa, that the cotton crop will be increased over 29 per cent. this year over last year's crop. The general outlook for the British government is very bright, and surely there is no time for delay in adjusting our own affairs to the best interests of the nation. England is in doubt as to the meaning of the inconsistency of the present situation in America, as shown above, since short crop means high price for raw material, and yet an overplus of manufactured articles seems to be the explanation of the low price of finished material. "It is difficult to get at the truth from contradictory statements of this kind," comes from an English review.

R. J. H. DeLoach
State College of Agriculture,
University of Georgia

SPECIAL ARTICLES

RESTING SPORES OF THE POTATO FUNGUS (PHYTOPHTHORA INFESTANS)

The potato fungus, *Phytophthora infestans,* has been carried in pure culture in the botanical laboratory of the University of Vermont continuously since 1904. Various natural and artificial media have been tried in the hope of securing additional information as to the ability of the fungus to produce

sexual or resting spores. As reported in our earlier paper,[1] oogonium-like bodies were found almost immediately after the inception of this work, in cultures on raw potato, lying in the mycelium close to the surface of the substratum. Subsequently they were found in greater abundance in potato gelatin cultures, here imbedded in the culture medium. Growth with varying degrees of vigor has also been secured upon several other synthetic media, including some modifications of the lima-bean agar, recommended by Dr. G. P. Clinton. The oogonium-like bodies have, however, been found but rarely upon any medium except the potato gelatin and the lima-bean agar. Under favorable circumstances they have been obtained in these in sufficient abundance to permit much more convincing study of the details of their development than was reported in our former paper. The most important advance, however, is the discovery of what appears to be fully matured resting spores. The oogonium-like bodies are about 30 microns in diameter, hence distinctly larger than the regular sporangia (conidia) and so different in appearance and mode of production as to preclude the idea that they are closely related to them. The character of the wall especially differentiates these two reproductive bodies, the oogonium-like bodies soon developing a thicker wall, immediately in contact with cytoplasm, which may show stratification and which in turn may be enveloped in an external envelope, of which the details as to development and structure vary with the medium in which they lie. No body clearly comparable to an antheridium has as yet been discovered. Nevertheless numerous examples have recently been found where these oogonium-like bodies have apparently developed into mature resting spores. These have a thick spiny brown exospore with dense granular contents, bearing a general resemblance to the oospores of related Peronosporales. None have as yet been germinated hence it remains to be proved whether they do actually function as resting spores. We have found similar bodies in potato leaves rotted by *Phytophthora*. There is need of further painstaking work, including cytological studies now being made by Dr. Lutman, before final conclusions are justifiable, but the evidence at hand encourages the hope that we have in hand the long sought for resting spores of *Phytophthora infestans*.

[1] A paper dealing with this subject was read by the present writer and N. J. Giddings before the last meeting of the Botanical Society of America and abstracted in SCIENCE (N. S., XXIX., 271). The removal of Mr. Giddings to West Virginia has left the responsibility for directing further study with the writer, who is fortunate in now having the assistance of Dr. B. F. Lutman and Mr. C. R. Orton. Professor H. A. Edson has also assisted, especially in devising culture media.

L. R. JONES

BOTANICAL LABORATORY,
UNIVERSITY OF VERMONT,
October 15, 1909

COLLECTION OF THE ÆCIAL STAGE OF CALYPTOSPORA COLUMNARIS (ALB. & SCHW.) KÜHN

THE æcial stage of the blueberry rust, *Calyptospora columnaris* (Alb. & Schw.) Kühn, was collected on *Abies balsamea* near Pictou, N. S., by the writer on July 14 of the present year.

Wintered telial material of this rust which is abundant on the blueberry (*Vaccinium pennsylvanicum*), was sent to Dr. J. C. Arthur for his culture work. He found the teliospores viable and on his suggestion search was made in the vicinity of the collection for the æcial stage. A *Peridermium* was found on the leaves of *Abies balsamea*, which agreed with the description of *Peridermium columnare*. Part of the collection was forwarded to Dr. Arthur, who determined it as the æcial stage of *Calyptospora columnaris*, and this as the first collection in North America.

This *Peridermium*, which could be easily recognized in the field by its yellow color, due to the orange-colored spores, was found sparingly distributed over an area of several square miles on the young leaves of the lower branches of its host. In no case was it abundant, only a few leaves being affected. In several places the leaves of young trees a few inches from the ground showed a more pronounced infection,

and in every instance the swollen stems of rusted blueberry grew among or just beneath the infected leaves.

The delicate peridium disappeared in a few days after the escape of the spores, or the infected leaves curled up and fell from the tree. Several collections were made during the summer, the last being on August 15.

W. P. FRASER

PICTOU, N. S.

THE SMOOTH HOUND, AND SOME OTHER FISHES IN NEW JERSEY

AMONG a collection of fishes made during the past season at Corson's Inlet, by Dr. R. J. Phillips, is an interesting fœtal shark. It is one of six removed from a female which measured three feet nine inches, taken on May 16, and was attached to the uterus of the mother by a placenta. This fact is interesting in that it points to the alleged essential character distinguishing *Cynais* from *Mustelus*. Upon comparison with other examples from our Atlantic coast, and the types of *Mustelus equestris* Bonaparte (= *Mustelus mustelus*), I find no difference whatever, except as may be allowed due to age. The presence of a lateral cusp on each side of the median one, in the case of the teeth, is distinct in small specimens, but as they grow larger the outer or anterior teeth at least seem to be smoother. I shall therefore feel obliged to consider the common smooth hound along the New Jersey coast to be *Mustelus mustelus*, thus substantiating Dr. Günther's record for New York in 1870. A fine small example of *Elops saurus*, the first definite record for this fish in New Jersey waters, was taken October 9. *Clupea harengus*, taken on June 6, is also the first definite record in New Jersey for that species. Other interesting species obtained are: *Eulamia milberti, Anchovia brownii, A. mitchilli, Kirtlandia vagrans laciniata, Menidia menidia notata, Mugil cephalus, M. curema, Selene vomer, Trachinotus falcatus, Pomatomus saltatrix, Orthopristis chrysopterus, Stenotomus chrysops, Micropogon undulatus, Menticirrhus americanus, Stephanolepis hispidus, Alutera schœpfii, Tetrodon maculatus, Chilomycterus schœpfi, Myoxocephalus æneus, Prionotus carolinus, P. evolans strigatus* and *Pseudopleuronectes americanus.*

HENRY W. FOWLER

ACADEMY OF NATURAL SCIENCES,
PHILADELPHIA, PA.,
November 6, 1909

SOCIETIES AND ACADEMIES

THE NEW YORK ACADEMY OF SCIENCES
SECTION OF BIOLOGY

A REGULAR meeting of this section was held at the American Museum of Natural History on October 11, 1909. In the absence of Mr. Frank M. Chapman, chairman of the section, Professor N. L. Britton presided. The evening was devoted to a paper on "Common Mushrooms and How to Know Them," by Miss Nina L. Marshall.

Miss Marshall, who is the author of a popular book on mushrooms, exhibited a series of beautifully colored slides illustrating the principal types of mushrooms. She dwelt especially on the ecology of the different forms and on their economic importance to man. The distinctive characters of the poisonous and non-poisonous kinds were emphasized.

AT the regular meeting held at the American Museum on November 8, 1909, Chairman Frank M. Chapman presiding, the following papers were read:

A Naturalist in the Straits of Magellan: Mr. CHAS. H. TOWNSEND.

The speaker gave an account of personal experiences in the Straits of Magellan while a member of a scientific expedition to that region several years ago. He spoke at length of the more interesting mammals, birds, fishes and plants seen or collected. The paper also dealt with the habits of the native tribes of that region. Those living along the more westerly channels of the straits go almost naked, subsist mainly on shell-fish and, in the speaker's opinion, are the lowest among primitive races of man. They are fast disappearing and should be carefully studied.

The paper was illustrated by lantern slides mostly from photographs by the author.

A Trip through Tropical Mexico: DR. ALEXANDER PETRUNKEVITCH.

The author spent two months during last summer in the lowlands of tropical Mexico collecting arachnida and other invertebrates for the American Museum of Natural History. The paper

dealt with his experiences in the field. Many interesting forms were observed and collected, some of which the speaker exhibited.

L. HUSSAKOF,
Secretary

AMERICAN MUSEUM OF NATURAL HISTORY

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

AT the 435th regular meeting of the society, held October 26, 1909, the president, Dr. J. Walter Fewkes, spoke on "The Preservation of Cliff-dwellings," his remarks being illustrated with lantern slides.

"The preservation of cliff-dwellings," said the speaker, "is one aspect of a more comprehensive problem now attracting great attention, the conservation of our resources. The protection of the antiquities of our country is imperative, for if neglected much valuable material pertaining to prehistoric America will be destroyed by the elements or by vandals in a few years." Excavation and repair of cliff-dwellings are necessary not only to put these interesting relics of the past in such condition that tourists may obtain correct ideas of this type of prehistoric architecture but also to furnish students with data for comparative studies.

The two cliff-dwellings that already have been repaired by the government are Spruce-tree House and Cliff Palace, both of which ruins are situated in the Mesa Verde National Park, Colorado.

The field work of repair of cliff-houses under direction of the Secretary of the Interior was in charge of Dr. Fewkes, who was detailed for that work by the secretary of the Smithsonian Institution. The treatment of these ruins consisted of excavation and repair. The ideal is educational and no restoration was attempted. No changes were made in the skylines of the walls, the purpose of the work being to preserve as far as possible the picturesque characters of the ruins. The condition of Spruce-tree House and Cliff Palace before and after the operations was illustrated by lantern slides made from photographs taken from approximately the same places. The speaker pointed out the many difficulties encountered in the field work, as isolation of the ruins, scarcity of water and inaccessibility of the ruins from the top of the mesa. He dwelt especially on the magnitude of the work at Cliff Palace, the largest cliff-dwelling in the southwest, and on the discovery of buried terraces having retaining walls and ceremonial rooms in the talus in front of the secular rooms.

Both Spruce-tree House and Cliff Palace have been completely excavated and repaired so that a visitor can now walk without difficulty or danger from one end to the other through deserted courts, plazas and rooms, and readily examine all architectural features. All walls in danger of falling have been repaired and new foundations provided wherever necessary.

Dr. Fewkes also threw on the screen views of the large cliff-dwellings lately discovered in the Navaho National Monument in the neighborhood of Marsh Pass, northern Arizona. While the dimensions of some of these cliff-dwellings are not less than those of Cliff Palace, they lack the picturesqueness and the fine masonry of the latter. The Navaho Monument cliff-dwellings are rarely more than two stories high and most of the ceremonial rooms are rectangular. These buildings are, however, among the best preserved in the southwest and their chambers might be called more appropriately abandoned rooms rather than ruins, the broom being in many cases more necessary than the spade to put them in condition for tourists and students. It is fortunate for historical science that these houses are now protected from vandals and it is to be hoped that their walls, some of which are tottering, will be repaired before it is too late.

JOHN R. SWANTON,
Secretary

THE WASHINGTON CHEMICAL SOCIETY

THE 193d meeting of the Washington Chemical Society was held at the George Washington University, on Thursday, November 11, 1909. President Walker presided. The papers presented were: "The Rôle of Water in Minerals," by W. F. Hillebrand, and "The Exact Determination of Sulphur," by J. Johnston.

The election of officers for 1910 resulted as follows:

President—G. H. Failyer.

First Vice-president—W. W. Skinner.

Second Vice-president—J. M. Bell.

Secretary—J. A. LeClerc.

Treasurer—F. P. Dewey.

Councilors—E. T. Allen, P. H. Walker, L. M. Tolman.

Members of the Executive Committee—M. X. Sullivan, H. C. P. Weber, H. E. Patten, S. S. Voorhees.

The attendance was 106.

J. A. LECLERC
Secretary

SCIENCE

FRIDAY, DECEMBER 10, 1909

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE FOOD SUPPLY OF THE FUTURE[1]

FROM various sources we have heard of late warnings of a deficiency in the food supply of the future population of the United States.

Thus President James J. Hill in his address before the Bankers' Association, and more elaborately in his recent article in *The World's Work,* sets forth in striking terms the growth of our population and the present limits of wheat production and predicts a shortage of not less than 400,000,000 bushels by the middle of the present century unless radical improvements in the prevailing methods of farming are speedily inaugurated.

Davenport, in his address at the dedication of Agricultural Hall at the University of Maine, calculates that if the rate of increase of population in the past one hundred years be maintained, the end of the twentieth century will see us with a population of twelve hundred millions, and emphasizes the fact that the agriculture of the future must be enormously productive in order to feed these teeming millions. He says:

> The conditions that have just been discussed will not be temporary and transient; they will be enduring, yes, permanent, and they must be met by a permanent agriculture—a thing the world has never yet succeeded in establishing. No race has ever yet learned to feed itself except at the expense of the fertility of its own or some other country. Other races have come up against this problem and have gone down under it. . . .
>
> There is to be, in the very near future, a struggle for land and the food it will produce

[1] Presidential address delivered before the American Society of Animal Nutrition at Chicago, Ills., November 27, 1909.

such as the world has never yet beheld. He who knows where and how to look can see it coming. The African activity among western European nations is a part of it. It is always cheaper to move when over-population and failing fertility threaten a shortage of food—providing there is any place to move into; that is, providing we can dispossess the other party and his land is worth the contest.

However that may be as an abstract proposition, for us there is no moving. For us there are no more "new worlds." For us there is little more "out west." Our fortune and our future, whatever they may be, are staked down on the American continent. Literally, "here we rest," and whether we like it or not, we must devise and establish a permanent agriculture or go down in the attempt.

Much the same general line of thought was followed by President J. L. Snyder in his annual address before the Association of American Agricultural Colleges and Experiment Stations, but with special emphasis on the social significance of a straitened food supply. He said:

. . . agriculture has contributed to democracy more than we can estimate by furnishing our people with an abundant food supply. So fertile has been our land, so extensive our fields, so abundant our harvests of grain and fruit, that the best and highest grades of food have been within the reach of every citizen who has been willing to do an honest day's work. It matters not what his occupation and social position, be they ever so humble. He and his family enjoy practically the same kinds of food as that enjoyed by families of wealth and prominence. In the dinner pail of the man who works in the mill, in the mine, or digs the ditches in our city streets, can usually be found wheat bread, meat, butter, fruit and coffee. What more does any one have? . . .

Caste and class distinction can make little headway among a people who all live on the same kind of food. As long as the working man has in his tin pail as good a dinner as his superintendent or as the mayor of his city, his prejudices will be moderate. He will maintain his self-respect and feel and act the man. It is when the pangs of hunger begin to pinch that men give way to prejudice and passion.

After pointing out that unless the food supply keeps pace with the increase of population, there will not be enough of the better foods to go around, he says:

The history of other countries tells us what would soon follow. Two families could not or would not occupy the same pew in church while one lived on white bread and meat and the other on black bread and potatoes. There is a social distinction there that can not be bridged. They would not even attend the same church or belong to the same social organizations. Our people would separate into classes and become estranged from each other. The power usually goes with wealth, but the men compelled to live on cheap food would soon get into the same political party and perhaps gain control of the national government.

and quotes from a letter of Lord Macauley to an American friend as follows:

. . . The day will come when the multitudes of people, none of whom has had more than half a breakfast or expects to have more than half a dinner, will choose a legislature. Is it possible to doubt what sort of a legislature will be chosen? . . . There will be, I fear, spoliation. The spoliation will increase the distress; the distress will produce fresh spoliation. . . . Either civilization or liberty will perish.

Even if we question the estimates of rate of increase in population on which these warnings are based, and however much weight we may attach on the other hand to estimates of increasing agricultural production per acre, it would be foolish in the extreme to close our eyes to the fact that the intensity of the demand for food by our future population will exceed anything we have yet known. Whether this state of affairs is to come about more or less rapidly is important chiefly as it gives us more or less time to prepare for it.

This is not the occasion to discuss problems of crop production nor of the conservation of soil fertility, but there are other aspects of the question which intimately concern us as stock feeders.

The problem of food supply is essentially

a problem of energy supply. While a small proportion of our food during the earlier years of life serves to build up the bodily machinery, by far the larger part of it is simply the vehicle by means of which chemical energy is introduced into organism, to be liberated again as work or heat in the performance of the vital functions. Briefly and crudely stated, food is the fuel of the body. The ultimate source of this energy, so far as we are concerned, is the sun. Crops are produced by means of solar radiation and food represents the stored-up energy of the sun's rays. The continuance of life upon the earth is conditioned upon the ability of the plant to effect this storage of energy and the density of population which a country can support from its own resources is limited absolutely by the amount of solar energy which can be recovered in the form of food products.

In view of this absolute dependence on solar radiation, it is a rather startling fact that the larger part of the energy stored in an acre of crop is contained in inedible products. From one half to two thirds of the organic matter of the corn crop, for example, is contained in the stover and cobs and about sixty per cent. of that of the average wheat crop in the straw. Furthermore, grain itself is not adapted for direct consumption by man, but undergoes various processes of preparation, giving rise to numerous unavailable by-products. For example, in the milling of wheat, about 25 per cent. of the grain passes into the offals and only 75 per cent. serves for purposes of human nutrition. In other words, out of the total energy stored up by the growth of an acre of wheat only about 30 per cent. serves directly for the nutrition of man. Substantially the same thing is true in greater or less degree of other food crops, while the grasses and leguminous forage crops which play so important a rôle in modern agriculture are, of course, entirely useless as human food.

It is clear that as population becomes denser and agriculture more intensive, it will become essential to utilize the energy of these by-products as completely as possible. When we number 500,000,000 we can not afford to throw 60 per cent. of the energy of the wheat crop into the manure heap if it is possible to save any of it. The agency for effecting this saving is our domestic animals. They are able to consume these by-product materials which man can not use and to render available a portion of their energy, using it in the first instance to support their own lives, but also storing up for man's use a certain part of what would otherwise be a total waste. As the demand for food grows more intense, it will become increasingly important to so husband these by-products and combine them into efficient rations, and to feed these rations under such conditions and to such types of animals, as to save the largest possible percentage of the energy which they contain.

It scarcely need be said that we are still far from doing this. Our rations are too often faulty and fed to inferior animals under unfavorable conditions, and only a short railway journey is necessary to convince one of the enormous waste of forage taking place every year, while our by-product feeding stuffs compete with native products in the markets of the old world.

With our relatively sparse population, this has hitherto been a country not only of cheap food, but especially of cheap meat, and we have been fond of drawing the contrast between the diet of our laborers, with its abundance of animal food, and that of the European laborer, and whether rightly or wrongly, have attributed much of the

greater efficiency of our workmen to this difference in diet. This abundant meat supply has been drawn especially from the vast corn fields of the Mississippi valley. Not only have our by-products gone to waste, but material available as human food has been converted into meat and milk. While this concentration of grain into higher priced and more marketable products has been in the past and to a degree still is entirely justified economically, nevertheless, the conversion of corn, or of any food grain, into meat is an exceedingly wasteful process. Jordan[3] computes that in the production of beef or mutton only about 2¾ per cent. of the digestible organic matter consumed by the animal is recovered as human food in the edible portion of the carcass, while even in pork production this percentage rises to only about 15½ per cent. Facts like these make it evident that we can not continue indefinitely to use edible grains as stock food—to take the children's bread and cast it to the beasts. The waste of energy in the transformation is too great. Nor is it any answer to say that wheat and not corn is the bread grain of the western world. The irresistible economic pressure of population will sooner or later compel us either to use corn as human food or to utilize the land now devoted to corn culture for other crops which shall yield more available nutriment, while the stockman will be forced to utilize by-product feeds to the utmost, not simply as a means of continuing meat as a prominent ingredient of our diet nor of providing animal foods as luxuries for the tables of the wealthy, but primarily as a means of conserving energy for human use. The feeder of the future will utilize by-product feeds to an extent as yet unrealized. He will pass in review the crude products of the farm, and all the hundred and one wastes of manufacturing operations, to see if perchance they still contain energy which he can extract. Like the miner, he will be ready to work low-grade ore, provided there is a sufficient margin of profit. Even the small amounts of available energy contained in such feeds as oat hulls, corn cobs and the like will be utilized and their waste energy saved as rapidly and as far as economic conditions render profitable, and to aid in rendering this possible is to render service to mankind.

[3] "The Feeding of Animals," 5th edition, p. 405.

It must be clearly understood, however, that this desirable end is not to be attained by any species of pious fraud. The manufacturers of mixed feeds are of late making much of the importance of by-product materials, a most sound proposition in itself, but one which hardly justifies all the corollaries which some of them appear to draw from it. That corn cobs, for example, contain a certain small amount of available energy does not render it an act of benevolence to induce the farmer to feed them, as Mike wanted his whiskey supplied, "unbeknownst," in some mixed feed with a high-sounding name or as an inconspicuous admixture to some well-known material. Such surreptitious kindness is in danger, in the long run, of recoiling upon its author. We shall not effect the needed economies of the future by coaxing or beguiling the feeder into utilizing these low-grade materials as ingredients of patent feeds or pre-digested mixtures or ready-balanced rations, but by teaching him their true value and educating him to make his own mixtures and balance his own rations. Personally, I am opposed on principle to mixed feeds, as I am to mixed fertilizers, not because many of them are not good of their kind, but for the reason that they minimize the intelligence of the farmer while they open a wide door for fraud on

the part of unscrupulous manufacturers and dealers.

The questions which we have been considering are very broad ones. They signify nothing less than a revolution, no less real because gradual, in the methods of agriculture as a whole and of the production of animal foods in particular, and the conditions which we must expect in the future will call for a much higher degree of skill in adapting means to ends than has been necessary in the past. What, then, should be the attitude of the institutions for agricultural teaching and research toward the problem of the future food supply?

Hitherto a large share of our experiments in feeding have had for their chief aim the improvement of present practises. They have sought to demonstrate how we may most efficiently convert grain into meat rather than how much of it can be saved for man's direct use. While such experiments have been of undoubted immediate utility, yet we shall soon have to reverse the point of view. Our experiment stations must take up in earnest the conservation rather than the exploitation of food resources, and our agricultural colleges, while still teaching the approved practises of the present, must as their chief aim seek to equip their students with a sound knowledge of underlying facts and laws and thus prepare them to meet the changing conditions of the future. In passing, too, I can not forbear calling attention to the fact that such an attitude toward the subject of animal husbandry and such methods of teaching it will serve to impart to it a higher pedagogic value than it generally has at present and will tend to make it a disciplinary as well as an informational subject.

Investigation of the questions here outlined must be of as broad and comprehensive a character as the problems to be solved. It should proceed, as I view it, along two main lines.

The first of these is a far more extensive and profound study of the scientific principles of animal nutrition than has yet been made.

That he may utilize the materials of which I have been speaking as completely as possible, the stockman needs to know in the first place what proportion of the energy which these various materials contain it is possible or practicable to recover. This knowledge will enable him to effect a wise selection in the compounding of rations, as well as have an influence upon the whole system of farming. In the second place, he needs to know the relative efficiency of different species, breeds and types of animals as converters of energy and how their efficiency is influenced by their natural or artificial environment.

These, however, are questions of animal physiology. In effect they ask how does the animal mechanism operate when supplied with different raw materials or placed under varying conditions. They are problems for rigorous scientific research and too much stress can not be laid upon the importance of such research. A well-known investigator, in a private communication from which I am permitted to quote, says:

> If we are to find new things, to get new ideas and to establish new lines of practical experimentation, we must first increase our field of opportunity by discovering new facts of general application. The progress of every branch of applied science has been made in this way and agriculture as well as the mechanic arts has shared in the benefits. The immense improvements of recent years in agricultural practise are largely founded on the purely scientific investigation of the preceding generation. The progress of the future must be founded on the scientific research of the present. That researches directed to immediate practical results frequently fail to yield all

that may be expected of them is largely due to the imperfections of the scientific work of the past and so makes evident the importance of undertaking in the present purely scientific studies which will lead to more definite and valuable results when future experiments are directed to the solution of practical problems.

No field of study opens so widely or presents so many opportunities for gaining knowledge of untold practical importance as that of animal nutrition.

As an illustration of the importance of gaining information respecting the fundamental problems of nutrition, the knowledge gained during the last few years respecting the constitution of the proteins may be mentioned.

As a result of these recent discoveries the whole question of protein assimilation is put in an entirely new light, multitudes of new questions are raised which must be answered before the feeding of these substances can be carried out on a scientific and intelligent basis. Heretofore in conducting feeding experiments proteins have been assumed to be of equal nutritive value and no definite evidence has been obtained which shows whether or not this is so. The wide differences in the constitution of the proteins of different animal and vegetable tissues at once raises the question of their relative nutritive value and the best methods of feeding them. Definite information respecting the nutritive value of each of the proteins commonly employed for food can not fail to show the way to new experiments with the use of commercial feeding stuffs and ought sooner or later to show the way to more productive and economical uses of these foodstuffs. A similar knowledge of the actual nutritive relations of phosphorus-containing substances[3] would likewise doubtless lead to similarly important results and deserves far more attention from a purely scientific standpoint than it has yet received.

Concerning all these questions we know something, but how little this is in comparison with what remains to be discovered. These are hard problems but they must be solved, before agricultural practise can have the benefit of what science can do for it.

Such work is intensely individual in character. The prime factor is the man. The principal service, and a highly important one, which an organization can render is to aid in providing the opportunity. Such service I earnestly hope our society may be able to perform, especially in the direction of impressing upon public sentiment as represented in legislative bodies, on the one hand, and upon the minds of benevolent men of wealth, on the other, hand, the fundamental importance of scientific research for the successful solution of the problem of the future food supply.

The other main line of experimental effort relates to the economic application in practise of the principles discovered by scientific investigation. Along this line, as I see it, there is a wide field open for fruitful experimental work, but this aspect of the subject was so fully dealt with last year in the report of the committee on organization that it seems superfluous to enter into it anew at this time.

Finally, along both lines of effort, but especially the second, there should be a coordination of effort and of spirit combined with the largest possible scope for individual initiative. This society owes its origin largely to a feeling of dissatisfaction over the more or less fragmentary and elementary nature of our past work. The discussions of the Cornell conference and of the last annual meeting of the society, as well as the incorporation into its constitution of the provision for a committee on experiments, clearly shows a desire on the part of investigators for closer relations with each other and a more broadly conceived program of investigation. It is hoped that the meetings of this society and the work of its committee may at least be serviceable in defining problems and improving methods.

But no program of agricultural investigation can be truly national in its scope which does not include the greatest agricultural agency perhaps in the world—

[3] The experiments of McCollum, at the Wisconsin station, published since this was written, are most important on this point.

certainly the predominant one in this country—the United States Department of Agriculture. No one would think of intimating that this great department has neglected the interests of the stockmen of the United States, but nevertheless, it is true that until very recently its work for them has been chiefly of the nature of veterinary and inspection work, as indeed it still is to a relatively large extent. The Bureau of Animal Industry has, it is true, established a dairy division and has begun to take up problems of feeding and especially of breeding with the modest appropriation for this purpose which congress has put at its disposal. The department should be put in position to do much more than it is doing, however. Its work in this field should be productive as well as protective. If the development of our waterways and the conservation of our forests, mines and water powers are subjects of national concern, surely the conservation of the food supply is worthy of attention. The magnitude of the live stock industry in itself, and especially its important relations to the future food supply of the nation which I have been endeavoring to point out, are such as to amply warrant the department in entering upon comprehensive investigations, both scientific and practical, into this subject and to fully justify congress in making all necessary appropriations. It is not alone our food supply, but our democracy, which is at stake.

It goes without saying that such an effort on the part of the national government should be made in harmony with the investigations which may be undertaken by other agencies. All the available forces should unite in the study of these important questions and no local jealousies should be allowed to stand in the way. While there may be problems of coordination and correlation still to be solved, I am confident that they are readily solvable, while it seems not impossible that in some respects this society might advantageously serve as an unofficial intermediary between state and national authorities.

I congratulate the society upon the notable increase in its membership during the past year and upon the very encouraging attendance upon its first annual meeting. If I understand the spirit and temper of its members, they desire to make the society something more than a pleasant club or a gathering for the reading of papers. It is my hope, which I believe I share with every member, that it may become an active agency in forwarding the solution of some of the problems which I have attempted to indicate in this address.

H. P. ARMSBY

A DEFENCE OF SANITY[1]

EVER since the reign of the illustrious Emperor Augustus, when Horace taught that all men are mad, there has been a wide-spread belief in the truth of the Roman poet's assertion. Yet few of us are wholly mad, and we shall not go far astray if we agree with a modern essayist that "every man has a sane spot somewhere." The actual degree of insanity from which any one of us suffers is a matter difficult of determination, since it can be made known only through the verdict of one's peers, who themselves in turn are demented. One can arrive at a correct judgment in an individual case only by comparing it with that which the most intelligent of the multitude, after long study and deep knowledge, have established as the norm. Any pronounced diversion from

[1] An address delivered at the opening of the fifty-seventh year of the College of Medicine of the University of Vermont, Burlington, November 3, 1909.

the teachings of the masters, unless there exist logical and credible grounds for diversion, stamps its possessor as one who is, in so far, without the pale of those who know.

But why should any one be without the pale? There is a wide-spread idea that the greatest evil in the world is ignorance, that education is its antidote, and that, with learning made easy, sanity and temperance and all things of good report will be the lot of mankind. While this represents obviously an extreme view, it is probably applicable to the majority of men in their relation to the majority of things. But biologists are agreed that what a man is is the result of the action of two forces, heredity and the environment, nature and nurture. While an educational environment may conduce to sanity, a man may, on the other hand, be handicapped by an ancestral perversion, which all the education in the world can never overcome. But the difficulty is further increased by the fact that the norm is ever changing, and, indeed, must ever change if the world is to progress. It follows, therefore, that the insanity of to-day becomes the sanity of tomorrow, if we are clever enough to bring the world around to our way of thinking. Stevenson said: "Give me the young man who has brains enough to make a fool of himself"—but it was the brains and not the fool that Stevenson really wanted.

In meditating much on the question as to the sphere in which human abnormality is most pronounced, I have come to believe that it is in beliefs and practises relating to the human body in health and in disease. And since the study of the human body in health and in disease is to be your life work, and since it will be your fate to come into intimate contact with many of these beliefs and practises, it has seemed to me fitting to devote the hour at my disposal to a consideration of some of them.

Before you leave these halls to practise your profession you will come to know that there has grown up in the course of many centuries an enormous mass of knowledge, for the most part well-ordered and rational, which constitutes the medical science and art of to-day. It is the contribution of many superior minds of all the world's ages. Some of its truths were known to the early Greeks, and from them down to the modern laboratory and clinic it has received a continual stream of accessions. But it is not accession only that has taken place, for to a large extent there has occurred a process of selection, a rejection and replacement of what has proved unsuitable, so that the medicine of to-day represents the survival of the fittest. Though the sifting process continually goes on and though everywhere there are points in dispute and unsolved problems, there yet exists the great fund of accepted medical knowledge, constituting a standard, according to which individual opinions concerning the body in health and disease are to be judged. It is convenient to classify this mass of knowledge, and so we recognize the specific divisions, not altogether sharply separated, such as anatomy, physiology, hygiene, bacteriology, pharmacology, therapeutics, surgery and neurology. In so far as one believes in the accepted principles of any one of these divisions he is pronounced by his fellows therein sane: in so far as he rejects them without adequate reason, he is looked at askance and with suspicion. And so it is with regard to specific matters within any one of these divisions. Obviously the amount of knowledge that the layman possesses of these various branches of medicine can be only small. The man on the street is pitifully ignorant of his own body.

in health and disease, and even more ignorant of the rise and present stage of development of the science and art of medicine. Largely because of this ignorance he is prone to grotesque opinions and statements. Such opinions are not, however, confined to the man on the street. A famous university professor, whose studies lie rather in the sphere of a dead language than of a living science, said recently to a colleague, in explanation of a slight attack of faintness, that the fumes of his gall had passed upward into his brain! The students of the first medical year now before me will soon learn to appreciate the strangeness of this physiological conception.

Most persons are eccentric to a greater or less extent on the subject of diet. Their notions of food, what they can eat and what they can drink, are often derived from a very crude kind of illogical deduction from their experience. To pounce upon a single unhappy food as the cause of an attack of indigestion after a feast, and pledge oneself to abstinence from it in the future, when there might be a score of causes, not only constitutes wilful defiance of the laws of logic, but it is never certain of insuring immunity from a subsequent similar attack of gastric disturbance. No one is free from imagined dietetic peculiarities, and there are differences only of degree between successive individuals in the dietetic series from the omnivore at one end to the vegetarian, the fruitarian, the nutarian and the raw-food advocate at the other. Of all these extremists perhaps the advocate of raw food is the most mad, for his sober contention is that if food be eaten in the uncooked state, its protoplasm on entering the body will at once be added, by a sort of accretion process, to the stock of protoplasm of the host! Such a simple, clear, attractive generalization has but one fault, that it fails to take into consideration the physiological phenomena of digestion, absorption and assimilation. While some persons are thus quarreling as to the kind of food that human beings should eat, others are discussing the quantity of food. There is undoubted soundness in Chittenden's main conclusion, supported by carefully conducted experiments, that most persons customarily take too much food, and his influence will undoubtedly conduce to ultimate good in inaugurating greater temperance in eating. Probably to most persons in the past, where food has been abundant, eating has been in large part a matter of sensuous indulgence. Greater sanity in this respect is surely being inaugurated, just as it has already been inaugurated in the matter of drinking alcoholic liquors.

Diet, however, constitutes but one sphere in which we all have our unreasoning personal hobbies. The character of one's domestic remedies for slight physical ills is also an indication of one's mental trend. The soothing syrup, hot drops, composition and catnip tea of our well-intentioned grandmothers, and the various messes, for the most part harmless, which were employed for the annual spring house-cleaning supposed to be required by the blood, were succeeded by the long list of proprietary or "patent" nostrums, many of which, it is now known, owed their popularity to their unsuspected content in alcohol; and these in turn are giving way to the more rationally prepared drugs of the pharmacopœia. But some persons like to think that the day of the drug has passed, and the drug-giving doctor is often held up to ridicule. Such persons, and happily they are few, are seemingly ignorant of the fact that at no time has the science of the drug ever been so exact as now; the physiological actions of drugs

were never so well known; the methods of their preparation and standardization were never so perfect; and their therapeutic use was never so effective; while the discovery of new drugs has greatly widened the range of their applicability in disease.

The subject of drugs leads us naturally to consider other methods of healing. In these amazing days of rapid living, when we rush over the earth's surface or through the air above or the waters beneath, when we joyfully jaunt to the icy ends of the earth's axis, or speak our messages straight into the wireless ether, confident of their destination, we are prone to become impatient with long-existing things—we are ever seeking the novel. With the seemingly slow progress of the difficult science and art of healing disease it is not strange that unorthodox methods of healing should have come into much favor. Medicine is not really making as slow an advance as often appears to the layman. The past quarter of a century has witnessed the rise of an entirely new and powerful medical science, bacteriology, and a series of brilliant onslaughts, which are certain of ultimate success, against that great enemy of mankind, the infectious diseases. As instances of what has been accomplished already one needs only to recall here the remarkable decrease in the death rate of diphtheria and tuberculosis. The success in surgery during the same period has been scarcely less brilliant. Internal medicine, fortified by great physiological and pathological discoveries, is rapidly forging to the front; while there is no considerable class of diseases in the knowledge and treatment of which progress has not been marked. Yet notwithstanding the hopeful augury, many men and women are dissatisfied with the results and the prospects. Nothing testifies so well to the tendency of humankind toward the bizarre as does the spread of osteopathy and Christian Science. In the foundations of both of these cults there can be found a few grains of scientific truth, but they are surrounded and concealed by such a fabrication of the false, the imaginary and the superficial, and the whole is often so exploited by ignorance and deception, that it would seem as if the normal mind must turn from them in disgust. Yet the mystery about them charms; and multitudes of otherwise worthy men and women are attracted by them and cheerfully give to them their own souls and bodies and the souls and bodies of their children.

Osteopathy is an outgrowth from the primitive conditions prevailing on our western frontier in the period preceding our civil war, when educated physicians were few, opportunities for rational treatment were fewer, and boldness in assertion and action counted far more than exact conformity to scientific truth. The founder of osteopathy was one of the rude, itinerant practical bone-setters, probably often clever in his attitude toward the sick. Though unlettered, he was possessed of a positive philosophy that found a sympathetic hearing in the home of many an unlearned frontiersman, who would have been ill at ease under the ministrations of one trained in the nice theories of academic medicine. Osteopathy was and still is full of unfounded assertions regarding the normal functioning of the bodily structures, and the nature and proper methods of cure of disease, though of late years its more enlightened practitioners appear to be endeavoring to harmonize its practises with certain accepted scientific principles. It speaks much of "lesions," by which it means, not the commonly accepted pathological idea of morbid changes, but rather "any structural perversion which by pressure produces or maintains functional

disorder." Of all parts of the body subject to lesions the spine is of fundamental importance, and "it is only in occasional cases of disease that no treatment is given to it." Treatment consists chiefly in correcting the structural perversion by manipulation with the hands and thus removing the pressure on the functionally disordered organs or on nerves or blood vessels supplying them. The osteopath serenely, with a single stroke of the hand, waves away the facts of scientific pathology. Says the prophet:

> I have concluded, after twenty-five years' close observation and experimenting, that there is no such disease as fever, flux, diphtheria, typhus, typhoid, lung-fever or any other fever classed under the common head of fever. Rheumatism, sciatica, gout, colic, liver disease, nettle-rash or croup, on to the end of the list of diseases, do not exist as diseases. All these, separate and combined, are only effects. The cause can be found, and does exist, in the limited and excited action of the nerves only, which control the fluids of parts or the whole of the body.

The cause of all diseases is "a partial or complete failure of the nerves to properly conduct the fluids of life." One can with difficulty suppress a feeling of admiration for the audacity with which time-honored scientific facts and principles are thus put aside. Osteopathy undoubtedly effects cures, but so does the medicine man of the savage tribe.

The founder of Christian Science prefaces her remarkable book with the words of Hamlet: "There is nothing either good or bad, but thinking makes it so." She does not seem to have been aware that these words were spoken at a time when Hamlet was strongly suspected of being out of his head, and when his actions and utterances seemed to justify such a suspicion. If osteopathy is presumptively assertive, Christian Science is no less so. Its founder avers:

> The cause of all so-called disease is mental, a mortal fear, . . . a fear that mind is helpless to defend the life of man and incompetent to control it.

The cure of all disease is equally simple:

> Through immortal Mind or Truth, we can destroy all ills which proceed from mortal mind. . . . We can not obey both physiology and Spirit, for one absolutely destroys the other, and one or the other must be supreme in the affections. . . . Fevers are errors of various types. The quickened pulse, coated tongue, febrile heat, dry skin, pain in the head and limbs, are pictures drawn on the body by a mortal mind. . . . Destroy fear and you end fever.

Of hay fever it is said:

> It is profane to fancy that the perfume of clover and the breath of new-mown hay can cause glandular inflammation, sneezing and nasal pangs.

There is no "ancestral dyspepsia":

> If a random thought, calling itself dyspepsia, had tried to tyrannize over our forefathers, it would have been routed by their independence and industry.

The Christian Science disciple asks this question:

> Should all cases of organic disease be treated by a regular practitioner and the Christian Scientist try truth only in cases of hysteria, hypochondria and hallucination?

The answer is not ambiguous:

> One disease is no more real than another. . . . Decided types of acute disease are quite as ready to yield to Truth as the less distinct and chronic form of disease. Truth handles the most malignant contagion with perfect assurance.

Philosophers have pointed out the crudities, contradictions and confusion of thought in the metaphysics of Christian Science. It is interesting to look over the long list of achievements of which it boasts, for they include, among others, the cures of cancer, fibroid tumor, astigmatism, epilepsy, tuberculosis, rickets, hernia, valvular disease of the heart, measles, asthma, Bright's disease, dropsy, croup, tonsilitis and a bad temper. Moreover, it is claimed

that by the same method broken bones have been instantaneously healed and the lost substance of disintegrated lungs has been restored. These wonders have been accomplished largely by the simple reading of Mrs. Eddy's book. But, however incredible may appear many of these so-called cures, what of the failures, what of the suffering and misery and death that might have been prevented? If scientific medicine, with all the skill which it can command and the hope which it can give to suffering humanity, often fails to justify its promises, what can be said of a would-be healing system which employs only the grotesque fantasies of a shallow mind? If Christian Science occasionally confers upon its believers a certain degree of cheerfulness of spirit and obliviousness to the petty annoyances of daily life, it numbs the senses and the courage and does not make the world's fighters. It is a lamentable fate for a child to be educated to a belief in such a debilitating panacea.

The same criticism can be made, in even stronger terms, of various minor kinds of mental or psychic healers, though here charlatanry is even more blatant. Many of these healers employ successfully the method of absent treatment. Even Mrs. Eddy says: "Science can heal the sick who are absent from their healers, . . . since space is no obstacle to Mind." The employment of absent treatment has received a considerable impetus with the advent of the telephone. How simple a matter it now is to ring up the healer in the depths of the night and request him to treat one's crying child from the recesses of his office a mile away! The credulous mother feels that something is being done for her suffering babe, even though the healer at his end of the wire merely turns over in his bed for another nap, having made a mental note of a fresh charge to be entered in his account book on the morrow. This picture is not overdrawn—its like may be seen any day in our cities.

It is a long step from such healers to the psychotherapist of the better class of the present day. In turning to psychotherapy I would have it understood that I speak of this subject in its broader applications. There is a notion, wide-spread in this country, which limits the term to the particular healing movement that was initiated at Emmanuel Church in Boston and has since extended to a few other churches. However instrumental this church movement may have been in arousing popular interest, the psychic method of dealing with disease is no new method, either in this country or abroad. The psychotherapist is an enlightened man, who recognizes and respects the achievements of scientific medicine, and if he is not a doctor of medicine himself he works hand in hand with the doctor of medicine. He makes no pretence that psychotherapy is a panacea, he simply claims that it is a valuable supplement to the physical agencies commonly employed by the physician, and is useful in certain so-called functional diseases of the nervous system. It is a mistake, I believe, to draw, as he does, a sharp distinction between organic and functional nerve diseases, the former being accompanied by morphological changes in nerve structures, the latter not being so accompanied: for I can not conceive the existence of a disease involving function without some physical abnormality. It is a mistake too, I believe, to assume the existence of a subconscious mind through which the psychic influence is mediated: for the phenomena which are now often relegated to the subconscious are capable of explanation without going beyond the sphere of physiology. The psychotherapist does not rely upon supernatural forces, he employs

the same agent that the hypnotist, the teacher and the parent employ, namely, suggestion, of which we all make daily use in our dealings with our fellows. If he couples with it the self-surrender involved in Christian faith, it is because he believes the mental attitude thus induced to be, with many persons, helpful in making suggestion efficacious. But I take it that religious faith is not the essential factor. The psychotherapist himself is, or at least tries to be, reasonably sane. It is his patients and his would-be patients who often make extravagant demands on, and hold extravagant beliefs in, his powers. That his method is effective in a limited variety of diseases and in a certain proportion of cases seems to be beyond question. But that it is not of wide applicability as a therapeutic agent and that it is efficacious only in certain hands is equally true. The danger of psychotherapy is twofold: There is, first, the possibility of its practise by ignorant and unprincipled persons for ignoble purposes; and secondly, while it endeavors to make the weak morally strong, it may, like christian science, have the reverse effect. It can be employed with the greatest prospects of success by intelligent physicians, though in addition to a high training in the principles of scientific medicine, they should have a right understanding of human psychology, and should possess a high degree of sympathy with suffering mankind, coupled with a genuine, earnest desire to relieve distress.

It may safely be assumed that, with few exceptions, any one who publicly professes to be opposed to what the consensus of the world's best judges favors, is either mentally or morally deformed. The world can advantageously dispense with the services of those who are constitutionally in a chronic state of opposition to the public weal. There are two interesting aberrant types of humanity, of this negative nature, who constitute themselves a public annoyance and a public enemy. I refer to the antivivisectionist and the antivaccinationist. While claiming the right to be arbiters of scientific method, they are out of sympathy with scientific ideals, suspicious of scientific motives and ignorant of scientific achievements. They are swayed, not by calm reasoning, but by feverish emotion. They either blindly can not, or willfully will not, see that if their demands are acceded to, pain and sorrow and death that might have been avoided will be brought to thousands of their fellowmen.

Nothing is more certain than that scientific experimentation on animals constitutes the very basis of physiological, pathological, medical and surgical advance. To question its value in scientific progress is as futile as to question the value of the railway or the telegraph in commerce. To assert that it is synonymous with the infliction of pain rests upon gravely mistaken assumptions regarding its procedures. To abolish it or fetter it by legislation would change our hopefulness of future victory over hitherto unconquered diseases into despair, and deprive future generations of the blessings which we believe we or our successors can give them. And yet there are persons who would not hesitate to abolish animal experimentation summarily were they given the power. Others, seemingly normal-minded in many respects, would seriously restrict it. And for what reason? Because of an overwrought emotionalism, a hyperesthesia regarding the possible sufferings of animals, a state of things in the laboratories that is wholly fancied, and an unwarranted distrust of the humanity of man. I have had occasion, during recent years, in defending the moral right and even duty of com-

petent persons to endeavor to benefit mankind through experiments on animals, to examine in some detail the writings of some of the leaders in the present outbreak of antivivisection sentiment, both in this country and in foreign countries, and I have been forcibly impressed with the low intellectual and moral tone therein displayed. Some of its writers frankly confess—and this is not exaggeration—that were it a question of the life of the animal or the human being, they would save the former—a sentiment the abnormality of which needs no comment. If the antivivisectionist is ignorant of what actually goes on in scientific laboratories, he has no moral right to inveigh against the method of animal experimentation. If he takes the rare position of doing so with full knowledge, he excludes himself from the multitude, who believe in the beneficence of science and put their trust in those who follow her lead. It is idle to maintain that the man who has the high-mindedness, the intelligence, the patience and the skill to perform the scientific experiment, needs the threat of a penal conviction to teach him obedience to the principles of common humaneness. The antivivisection movement is the least worthy and commendable of all movements that profess to be uplifting, and it is only those whose sense of moral proportions has become askew, who enter actively into it. For you who are soon to become practitioners of medicine it is a duty which you owe to your profession to instruct your patients concerning the methods and the value of animal experimentation and to influence them to maintain toward it an attitude of sanity.

To deny the value of the remarkable discovery of Jenner, now with more than a century's evidence in its support, and with recent allied discoveries confirming its scientific significance, is merely wilful. Yet a well-known writer concludes an extended discussion of the subject with these words:

> That vaccination is a gigantic delusion; that it has never saved a single life; but that it has been the cause of so much disease, so many deaths, such a vast amount of utterly needless and altogether undeserved suffering, that it will be classed by the coming generation among the greatest errors of an ignorant and prejudiced age, and its penal enforcement the foulest blot on the generally beneficent course of legislation during our century.

It is interesting that in the same volume the author utters a long lament over the neglect which the world has given to phrenology, and prophesies that in the coming century "it will prove itself to be the true science of mind." The author of these remarkable pronouncements, Alfred Russell Wallace, made important contributions to science during his early life, but there is a sad intellectual contrast between his discovery, announced coincidently with that of Charles Darwin, of the principle of the origin of species through the agency of natural selection in the struggle for existence, and his indefensible stand, sixty years later, regarding vaccination and phrenology.

Opposition to vaccination is not new. Even in the days of Jenner its opponents are said to have claimed that its tendency "was to cause bovine characteristics to appear in children: that they developed horns, hoofs and tails, and bellowed like cattle." The objections of recent years have been less picturesque, and have been confined largely to a denial of the efficacy of vaccination in the prevention of disease and the saving of life. Reliable statistics from communities where vaccination has been compulsory and has been rigidly enforced clearly disprove this claim. Thus, it is said on authority that in recent years the mortality from smallpox in France, where there is only a partial and

imperfect vaccination law, has been from ninety to one hundred times greater than in Germany, where vaccination is strictly required. During the Franco-Prussian war the French army lost 23,400 men by death from smallpox, and the German army only 450. In the greater city of New York, with its estimated population of over 4,000,000, and in which vaccination is rigidly performed, there were but nine deaths from smallpox during 1907, although one hundred years ago the disease was one of the great scourges. As a companion picture, the well-known case of Montreal in 1885 is strikingly instructive. During a period of several years vaccination had been neglected. Then a single individual, a Pullman car conductor, traveling from Chicago, brought the disease into the favorable locality. An epidemic swept over the city, and caused the death of 3,164 persons within nine months. It is much to be feared that this case will be paralleled with even more direful results in England, where, through the efforts of antivaccinationists, the soil has become well prepared. The antivaccinationist often denies the germ theory of disease, and objects to the whole modern treatment of infectious diseases by antitoxins, serums or vaccines, saying that they are poisons, and that the proper preventives of the diseases in question are cleanliness, pure air and sunlight. Poisons, cleanliness, pure air and sunlight are, indeed, magic words, and yet the microbe is a reality, not a theory. If cleanliness, pure air and sunlight—and what is more expensive for the masses?—have not availed, and the microbe has entered or threatens to enter the body, shall we leave him free to kill? Antitoxins, serums and vaccines are not empirical or artificial remedies; they are nature's antidotes to nature's poisons, and in this respect ought to be classed with cleanliness, pure air and sunlight.

While speaking of some of these fads and foibles of aberrant mankind, I am tempted to say a word about our greatest popular educator, the newspaper. Unfortunately, our newspapers, with few striking and commendable exceptions, are pronounced derelicts in the dissemination of sound scientific and medical ideas. With men of science, trained in sobriety and accuracy, "newspaper science" has become a synonym for the grotesque, the ridiculous, the sensational and the inaccurate. A justification of this on the ground of unavoidable reportorial haste is not to be accepted, nor can I sympathize with the policy that makes an assumed popular desire the excuse for filling the columns with that which is untrue and fantastic. Laboratories, clinics and hospitals are daily productive of serious discoveries, many of which are of inestimable value to the welfare of mankind and, if considered merely from the journalistic standpoint, are of great interest as matters of news. Yet the man on the street rarely finds these mentioned in his daily paper, although he has abundant opportunity to learn of the frivolous and the sensational. With such instruction, we can not always blame him for his beliefs. The newspaper might, if it would, become a great power for good in spreading correct information regarding scientific and medical facts and wholesome ideas regarding scientific and medical theories.

The final topic of which I shall speak is one that concerns the attitude, not so much of the public as of yourselves as practising physicians. The training of a physician is one which should inculcate in him the general principles of sanity and good judgment. Without going in detail into the qualities that make a physician professionally successful, I would urge upon you the very great importance of one thing, namely, correct diagnosis. Avoid

hastily, ill-considered diagnoses. If you find the stomach not performing its functions properly, your first thought will be to treat the stomach, and yet such a procedure might be useless, for the stomach may be affected only secondarily. Among civilized peoples there is constant communication between separated individuals or communities, and the one is constantly influencing the other. This influence may be performed by the aid of two mediums: by the written, spoken or telegraphed message, and by the transmission of material things, such as food, clothing, luxuries, or the thousand things upon which our lives and actions as civilized beings depend. Thus, while members of human society, we are not free, independent agents, each individual living his life in isolation from his fellows. The conditions are similar within a complex organism like the human body; there too no part is independent of the other parts. The correlation between the various organs of the body is a topic that is now looming large above the horizon of physiological discovery. There are two ways in which one organ is capable of influencing another: through nervous impulses and material substances. Nervous influences have long been recognized, but influence through the action of material substances constitutes a comparatively new subject. It is now known of several organs that they manufacture chemical substances, which exert characteristic physiological actions on the cells of other organs. Thus the acid which is formed by the glands of the stomach, and is essential to gastric digestion, acts upon the sphincter muscle at the plyorus in such a manner as to cause it to relax and open a passageway into the duodenum for the digested gastric contents. Once arrived within the small intestine, the acid then causes a contraction of the sphincter, which prevents the return of the chyme. But the duties of the acid are not yet completed. It proceeds to stimulate the epithelium cells of the lining wall of the small intestine and makes them produce a characteristic substance, recently discovered and called secretin. This passes from the cells into the blood-stream and takes two paths: one to the pancreas, where it stimulates the pancreatic cells to secrete their characteristic digestive juice; the other to the liver, the cells of which are similarly stimulated to produce bile. Any interference with the production of acid in the stomach may thus interfere with a whole train of physiological processes which are dependent upon it. Adrenalin, a peculiar chemical substance formed by the adrenal bodies, which in recent years has become valuable to the physician because of its extraordinary power of constricting blood vessels, acts normally within the body upon the whole sympathetic nervous system, and thus influences the various important organs supplied by the sympathetic nerves. There is much reason for believing that intimate relations exist, through the action of chemical substances as yet obscurely known, between the adrenal bodies, the pancreas, the thyroid, the liver and perhaps the heart and the stomach. But if the mutual relations of normal organs are so involved, it is easy to see how intricate the situation may become when an organ becomes diseased, and how difficult for the physician may become the problem of locating, from the assemblage of symptoms, the primary seat of the trouble. That the problem is not necessarily hopeless of solution is demonstrated daily by clever diagnosticians. One can not help having a profound admiration for the man who, armed with an intimate knowledge of nerve centers and nerve tracts, will from certain obscure paralyses specify the exact spot in the course of the tangled nervous system

where an offending tumor lies. My present purpose, however, is not so much to impress you with the difficulties of making a sane diagnosis, as to caution you against the making of an insane one. An ill-balanced judgment in diagnosing disease is one of the commonest faults of the physician, and if the nature of the disease is not discovered, the success of the treatment is not even problematical.

The moral of my tale is quickly drawn. It is, first of all, for you, who are to become healers of the sick, to be sane. It is for you diligently to seek after the truth, and, having found it, to follow its teachings. But you can do more than this, and it is your duty to do more. With your training and with your growing experience, your opinion in matters of health and of disease, in whatever pertains to the human body, will be sought and will deserve respect if that opinion is in accord with what learned men have declared to be wisdom. You will thus be called upon to be mentors and teachers. I plead, therefore, not only for sanity in your own beliefs and practises, but for the constant exercise of your enlightened influence toward the eradication of what has pithily been called "pestilential nonsense" from the minds of your patients and your fellow-men. Swayed by sentiment, they will often seek the bizarre, the foolish and the delusive. "The time will come," said a wise man, "when they will not endure the sound doctrine. . . . They will turn away their ears from the truth, and turn aside unto fables." They will hold to their opinions with the tenacity that is born of ignorance. Montaigne has said that "nothing is so firmly believed as that which a man knoweth least." You will have many opportunities to show to the world that the way toward strange gods is not the way of salvation. You should hail the chance of thus becoming missionaries of common sense to those less well equipped than you. May you make good use of your education and your powers, and, both as physicians and as citizens, always stand as staunch defenders of the gospel of sanity.

FREDERIC S. LEE

COLUMBIA UNIVERSITY

ANTON DOHRN, FOUNDER AND DIRECTOR OF THE NAPLES AQUARIUM

ANTON DOHRN, founder and director of the Naples Zoological Station, or, as it is more popularly called, "The Aquarium," died in Munich after a protracted illness, on September 26. His death severed one more link which connected the present generation with a group of great men, most of whom were his intimate friends, Darwin, Huxley, Virchow, DuBois-Raymond, Helmholtz and Pasteur. The story of his life is of special, no less than general, interest to Americans. Idealism rendered effective through the will and creative genius is the mark of an unusual combination of mental traits and that, in brief, was the keynote of his personality.

Anton Dohrn was born at Stettin in the year 1840. His father, a man in affluent circumstances, was extremely solicitous that his sons should fully appreciate the responsibility attaching to the possession of wealth; and the paternal admonition to the younger Dohrn to choose his own profession provided it was not a money-making one, proves that the form of idealism of the son, to which he always remained true, was in part, at least, inherited.

Those who had the privilege of knowing Professor Dohrn were greatly impressed, not only by his remarkable versatility, but by the great capacity he displayed in dealing successfully with men and affairs. His power to administer and direct the organization of a large institution never seemed to diminish his interest in, nor his ability to carry on scientific investigations of great importance. Honored by the personal friendship of the German Emperor, and received as a not infrequent guest by families of the greatest distinction in Europe, he never permitted the

orderly simplicity of his daily life to be disturbed by outside influences. Goethe's words emphasizing the necessity of plain living as essential to high thinking were constantly on his lips, and he furnished an excellent example of the simple life so often the subject of sermons, and so rarely practised.

Apart from his remarkable personality, there is a reason why Dohrn's life should be of particular interest to Americans, and that is the influence he exerted upon men who were actively identified with all progressive movements in institutions of learning. Shortly before his death the writer had the privilege of spending some time in the company of the late Mr. Daniel C. Gilman during his visit to the Naples Aquarium, and it was extremely interesting to notice the keen and appreciative interest he took in the work of the investigators then engaged in carrying on their studies in the laboratories. "Dohrn," he said, "was one of the first men whose advice I sought for on being elected to the presidency of the Johns Hopkins University, and when I asked him what he considered to be the really essential principle to be kept constantly in view in outlining the policy of a new university, he replied: 'Liberty! Liberty! Liberty!' and added: 'First get the best available men as professors, and do not spend too much money on buildings.'" The advice was not disregarded, for not only were the buildings of the Johns Hopkins University characterized by great simplicity in structure, but the motto selected for the university was "*Veritas vos liberabit.*" Dohrn's guiding principle in establishing the aquarium was to gather about him a body of investigators, and then to enlarge the institution so as best to meet the needs of these workers.

Many Americans carried away from Naples pleasant memories of a day spent on the *Johannes Müller*, the small steamer which made frequent excursions to different points about the Bay of Naples, either to collect specimens for exhibition in the aquarium, or for study by those engaged in scientific investigations. One of the most interesting features of these trips was the opportunity of listening to the story of the founding and development of the zoological station as it was told with almost boyish enthusiasm by Dohrn.

Scientist by profession, he had many of the temperamental qualities of the artist. If he had not possessed this rare combination of mental traits, his friend Joachim would not have put Dohrn's favorite Neapolitan "Fisherman's Song" to music and sent the score to Oxford, to be played at the ceremonies attending the conferring of an honorary degree upon his friend by the English university; nor would Hans v. Marée have asked to be allowed to decorate the walls of the library in the aquarium with a series of frescoes, which are considered by art critics to represent the best work of that artist.

Dohrn firmly believed in the unity of all forms of knowledge. He contended that men should not be classified arbitrarily as "scientists," "artists" or "litterateurs"; as individually they possessed but in varying degrees the temperamental qualities common to all. To lay stress upon these artificial divisions was to return in spirit to the period when classification and systematization were considered of more value than the actual study of vital facts.

Discussions as to the relative merits of science, art or literature failed to interest him, for he felt deeply that life in its broadest sense was for each individual the chief interest; the only essential difference was discoverable not in the object, but in the angle of vision of the observer.

His taste in literature and art was distinctly classical. Cicero, Horace, Shakespeare and Goethe were his favorite authors, selections from Beethoven, or Mendelssohn and Brahms the music he enjoyed the most. In pictorial art, color appealed to him more than form. Perhaps in this he had been influenced by his friend Böcklin. The whole scheme of organization of the aquarium revealed the broad sympathies of the man.

One of the chief reasons assigned for the selection of Naples in 1872 as the best place in which to place the station was the beauty and historical associations of the city and its

surroundings. These two factors Dohrn considered to be of the greatest importance in indirectly influencing the character of the work to be undertaken.

The events of the past year have proved how fortunate it was that Naples, and not Messina, as was originally intended, should be the site of the aquarium.

In the organization of the aquarium the university idea was developed to a degree never before practically realized. In practise as well as theory this was an institution of learning as distinct from teaching. Here are gathered together at one time as many as seventy or eighty representatives of the leading universities of the world; professors, assistants and occasionally undergraduate students, all engaged in carrying on investigations. (The expenses of the zoological station are in part defrayed by money received from the sale of entrance tickets to the aquarium, and in part by the subvention of different countries. Germany pays for 22 places in the laboratory, Italy for 9, the United States for 5, England for 3, Russia 4, Austria 2, Hungary, Holland, Belgium, Switzerland and Roumania each 1.)

Here zoologists, chemists, anatomists, physiologists, pathologists, practising physicians and professional philosophers are all intent upon the study of various problems, the solution of which will eventually throw more light upon the origin and nature of the vital processes in the lower organisms, and consequently and ultimately in man. Thoroughly imbued with the spirit of Darwin, Dohrn long ago realized that the only successful way to understand the complex phenomena of human life was to begin by studying the simpler manifestations in the lower animals. The continuity and similarity of the life processes in the whole scale of animal life is unbroken. "You scientists have little understanding of history," complained Mommsen; "Why assume," retorted Dohrn, "that history begins and ends with man's appearance on the earth? Here in the aquarium we are interested in ancient history, for here we study man's ancestors."

From the crest of the mountains back of Sorrento, turning to the south, one looks down upon the Gulf of Salerno, on whose shores for centuries stood the most famous medical school of medieval times, where were gathered from the shores of Africa and Europe the most renowned students of their day. To-day, only the memory of that school remains. Turning to the north one beholds the great expanse of the Bay of Naples, and by the aid of a glass discovers the aquarium, the institution which to-day has fallen heir to all that was best in the traditions of the Salerno school. The latter was a slow growth, the result of the labors of many men upbuilding painfully for many years while the Naples Aquarium was the creation of one man—Anton Dohrn, whose life was devoted to devising and perfecting unequaled facilities for the study of zoology; and he builded better than he knew, for he actually, although unconsciously, created a university. Year after year a greater number of trained investigators, representing practically all the civilized governments of the world, are gathered together at the aquarium than are to be found in any other institution in the world. Within this building, racial prejudices and differences are ignored or forgotten by the brotherhood of scholars who carry on their work for the benefit of their common humanity.

The scientific work of Dohrn has received generous commendation from his fellow workers in the sciences, but it still remains for those who labor to preserve the peace of the world to show their appreciation of the quiet, unostentatious but potent influence upon the thought of mankind of "the peace congress" which is continuously in session at the Naples Aquarium.

STEWART PATON
PRINCETON, N. J.

THE PALEONTOLOGICAL SOCIETY

AT the first meeting of the society at 10 A.M., on December 29, in the University Museum, Cambridge, there will be a Conference on the Aspects of Paleontology, the program of which is as follows:

Adequacy of the Paleontologic Record: Samuel Calvin, R. S. Bassler.

Interdependence of Stratigraphy and Paleontology: W. J. Sinclair, E. O. Ulrich.
Biologic Principles of Paleogeography: Charles Schuchert, F. H. Knowlton.
Paleontologic Evidences of Climate: T. W. Stanton, David White.
Migration: Henry S. Williams, Arthur Hollick.
Paleontologic Evidences of Adaptive Radiation: H. Fairfield Osborn.
Anatomy and Physiology in Extinct Organisms: Charles R. Eastman, Rudolf Ruedemann.
Contributions to Morphology from Paleontology: Wm. Bullock Clark, Charles D. Walcott.
Embryology and Paleontology: Richard S. Lull, William H. Dall.
Ontogeny and Paleontology: F. B. Loomis, Amadeus W. Grabau.
Phylogeny and Paleontology: Robert T. Jackson, D. P. Penhallow.
Paleontologic Evidences of Recapitulation: E. R. Cumings, L. Hussakof.
Isolation in Paleontology: John M. Clarke.
Continuity of Development from the Paleontologic Standpoint: W. D. Matthew, T. Wayland Vaughan.
Paleontology of Man: S. W. Williston, John C. Merriam.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION B, PHYSICS AND THE AMERICAN PHYSICAL SOCIETY

At the Boston meeting of the American Association for the Advancement of Science, Section B and the American Physical Society, will in general hold joint sessions for reading papers. The presiding officers will be Dr. L. A. Bauer, of Washington, chairman of Section B, and Professor Henry Crew, of Northwestern University, president of the Physical Society. The address of the retiring vice-president of Section B will be given by Professor Karl E. Guthe, of the University of Michigan. Section B will hold one joint session with Section A, at which several distinguished scientists have promised papers which will be of interest to other sections. Another session will be given to the discussion of the teaching of physics, perhaps in conjunction with Section L.

The program of special papers on research topics will be in charge of the secretary of the Physical Society and titles should be sent to him at Ithaca, N. Y. All titles should be in his hands by December 14, accompanied by a suitable abstract.

Ernest Merritt,
Sec. Am. Physical Soc.
Alfred D. Cole,
Sec. of Section B, A. A. A. S.

SECTION A, MATHEMATICS AND ASTRONOMY

Arrangements have been made for two joint sessions of Section A. The first of these is to be held jointly with Section B on Tuesday afternoon, December 28, and the second is to be a joint session with the American Mathematical Society on Wednesday morning. The vice-presidential address of Section B is to be given during the former of these sessions and that of Section A during the latter. The section will organize on Monday morning, and the sessions of Monday afternoon and Tuesday morning will be devoted almost exclusively to astronomical papers. Titles and abstracts should reach the secretary before December 15.

G. A. Miller,
Secretary of Section A

SECTION F, ZOOLOGY

Owing to a clerical error, the preliminary announcement of the Boston meeting wrongly states that a joint session will probably be arranged between Section F and the American Society of Zoologists. The officers of Section F proposed a plan for referring to the American Society of Zoologists the reading of all worthy zoological papers by authors who are not members of that society; but it was rejected by a vote "to keep the meetings of the American Society of Zoologists entirely independent." As a result, it is planned by the officers of Section F to hold on Friday, December 31, a meeting for reading of papers by members of that section who do not on their personal responsibility arrange for presenting their papers in the meetings of the American Society of Zoologists or elsewhere. On the days when that society is reading technical papers, Section F will offer a series of programs designed to appeal to the intelligent public and to men of science who are not primarily zoologists. Thus the conflicting

meetings which so much disturbed the equanimity of zoologists at Baltimore last year will be entirely avoided.

M. A. Bigelow,
Secretary of Section F

THE CONVOCATION WEEK MEETINGS OF SCIENTIFIC SOCIETIES

The American Association for the Advancement of Science and the national scientific societies named below will meet at Boston, Mass., during convocation week, beginning on December 27, 1909.

American Association for the Advancement of Science.—Retiring president, Professor T. C. Chamberlin, University of Chicago; president, Dr. David Starr Jordan, of Stanford University; permanent secretary, Dr. L. O. Howard, Cosmos Club, Washington, D. C.; general secretary, Professor Dayton C. Miller, Case School of Applied Science, Cleveland, Ohio.

Local Executive Committee.—H. W. Tyler, chairman; Thomas Barbour, J. S. Kingsley, Edward R. Warren, John Warren, George W. Swett, secretary.

Section A, Mathematics and Astronomy.—Vice-president, Professor Ernest W. Brown, Yale University; secretary, Professor G. A. Miller, University of Illinois, Urbana, Illinois.

Section B, Physics.—Vice-president, Dr. Louis A. Bauer, Carnegie Institution, Washington, D. C.; secretary, Professor A. D. Cole, Vassar College, Poughkeepsie, N. Y.

Section C, Chemistry.—Vice-president, Professor William McPherson, Ohio State University; secretary, C. H. Herty, University of North Carolina, Chapel Hill, N. C.

Section D, Mechanical Science and Engineering.—Vice-president, Professor John F. Hayford, Northwestern University; secretary, G. W. Bissell, Michigan Agricultural College, East Lansing, Mich.

Section E, Geology and Geography.—Vice-president, Reginald W. Brook, Canadian Geological Survey; secretary F. P. Gulliver, Norwich, Conn.

Section F, Z[illegible]ogy.—Vice-president, Professor William E. R[illegible]r, La Jolla, Cal.; secretary, Professor Morris A. Bigelow, Columbia University, New York City.

Section G, Botany.—Vice-president, Professor David Penhallow, McGill University; secretary, Professor H. C. Cowles, University of Chicago, Chicago, Ill.

Section H, Anthropology.—Vice-president, Dr. W. H. Holmes, Bureau of American Ethnology; secretary, Dr. George Grant MacCurdy, Yale University, New Haven, Conn.

Section I, Social and Economic Science.—Vice-president, Byron W. Holt, 54 Broad St., New York City; secretary, Dr. John Franklin Crowell, 44 Broad St., New York City.

Section K, Physiology and Experimental Medicine.—Vice-president, Professor C. S. Minot, Harvard Medical School; secretary, Dr. Wm. J. Gies, College of Physicians and Surgeons, Columbia University, New York City.

Section L, Education.—Vice-president, Dean James E. Russell, Columbia University; secretary, Professor C. R. Mann, University of Chicago, Chicago, Ill.

The American Society of Naturalists.—December 29. President, Professor T. H. Morgan, Columbia University; secretary, Dr. H. McE. Knower, University of Toronto, Toronto, Can. *Central Branch.* President, Professor R. A. Harper, University of Wisconsin; secretary, Professor Thomas G. Lee, University of Minnesota, Minneapolis, Minn.

The American Mathematical Society.—December 28–30. President, Professor Maxime Bôcher, Harvard University; secretary, Professor F. N. Cole, 501 West 116th St., New York City.

American Federation of Teachers of the Mathematical and Natural Sciences.—December 27, 28. President, Professor H. W. Tyler, Massachusetts Institute of Technology; secretary, Professor C. R. Mann, University of Chicago, Chicago, Ill.

The American Physical Society.—President, Professor Henry Crew, Northwestern University; secretary, Professor Ernest Merritt, Cornell University, Ithaca, N. Y.

The American Chemical Society.—December 27–31. President, Dr. Willis R. Whitney, General Electric Company, Schenectady, N. Y.; secretary, Professor Charles L. Parsons, New Hampshire College, Durham, N. H.

The Geological Society of America.—December 29, 31. President, Dr. G. K. Gilbert, U. S. Geological Survey; secretary, Dr. E. O. Hovey, American Museum of Natural History, New York City.

The Association of American Geographers.—December 30–January 1. President, Professor W. M. Davis, Harvard University; secretary, Professor Albert P. Brigham, Colgate University, Hamilton, N. Y.

The American Society of Vertebrate Paleontologists.—December 27–29. President, Dr. J. C.

Merriam, University of California; secretary, Dr. E. S. Riggs, Field Museum of Natural History, Chicago, Ill.

The American Society of Biological Chemists.—December 28–30. President, Professor Otto Folin, Harvard Medical School; secretary, Professor William J. Gies, 437 West 59th St., New York City.

The American Physiological Society.—December 28–30. President, Professor W. H. Howell, Johns Hopkins University; secretary, Dr. Reid Hunt, Hygienic Laboratory, 25th and E Sts., N. W., Washington, D. C.

The Association of American Anatomists.—December 28–30. President, Professor J. Playfair McMurrich, University of Toronto; secretary, Professor G. Carl Huber, 1330 Hill St., Ann Arbor, Mich.

The Society of American Bacteriologists.—December 28–30. President, Dr. J. J. Kinyoun, Washington, D. C.; secretary, Dr. Norman MacL. Harris, University of Chicago, Chicago, Ill.

The American Society of Zoologists.—Eastern Branch, December 28–30. President, Professor Herbert S. Jennings, Johns Hopkins University; secretary, Dr. Lorande Loss Woodruff, Yale University, New Haven, Conn.

The Entomological Society of America.—December 29, 30. Secretary, J. Chester Bradley, Cornell University, Ithaca, N. Y.

The Association of Economic Entomologists.—December 28, 29. President, Professor W. E. Britton, Connecticut Agricultural College; secretary, A. F. Burgess, U. S. Department of Agriculture, Washington, D. C.

The Botanical Society of America.—December 28–31. President, Professor Roland Thaxter, Harvard University; secretary, Professor D. S. Johnson, Johns Hopkins University, Baltimore, Md.

American Nature Study Society.—January 1. President, Professor C. F. Hodge, Clark University; secretary, Professor M. A. Bigelow, Teachers College, Columbia University, New York City.

Sullivant Moss Society.—December 30. President, Professor Bruce Fink, Miami University, Oxford, O.; secretary, Mrs. Annie Morrill Smith, 78 Orange St., Brooklyn, N. Y.

Wild Flower Preservation Society.—President, Professor Chas. E. Bessey; secretary, Dr. Charles Louis Pollard, New Brighton, N. Y.

The American Psychological Association.—December 29–31. President, Professor Charles H. Judd, University of Chicago; secretary, Professor A. H. Pierce, Smith College, Northampton, Mass.

The American Anthropological Association.—December 27–January 1. President, Dr. W. H. Holmes, Bureau of Ethnology; secretary, Dr. Geo. Grant MacCurdy, Yale University, New Haven, Conn.

The American Folk-lore Society.—Week of December 30. President, Dr. John R. Swanton, Bureau of American Ethnology; acting secretary, Dr. R. B. Dixon, Peabody Museum, Cambridge, Mass.

Association of Mathematical Teachers in New England.—December 28. President, Charles A. Hobbs, Watertown, Mass.; secretary, George W. Evans, Charlestown High School, Boston, Mass.

Physics Teachers of Washington, D. C.—Meets in conjunction with American Federation of Teachers. President, W. A. Hedrick, McKinley High School, Washington, D. C.; secretary, Dr. Howard L. Hodgkins, George Washington University, Washington, D. C.

American Phytopathological Society.—December 28–30. President, Dr. L. R. Jones, University of Vermont; secretary, Dr. C. L. Shear, U. S. Department of Agriculture, Washington, D. C.

American Alpine Club.—December 30. Secretary, Dr. Henry G. Bryant, Room 806 Land Title Building, Philadelphia, Pa.

American Breeders' Association.—Meeting of Eugenics Committee. Secretary, Dr. Chas. B. Davenport, Cold Spring Harbor, N. Y.

SCIENTIFIC NOTES AND NEWS

The Philosophical Society of Washington held on December 4 a meeting commemorative of the life and services of Professor Simon Newcomb, late president of the society. The program included addresses by the Honorable James Bryce, Dr. Milton Updegraff, Dr. R. S. Woodward, Dr. L. O. Howard and Dr. E. M. Gallaudet.

Professor Edward C. Pickering, director of the Harvard College Observatory, has been elected a vice-president of the American Philosophical Society, to fill the unexpired term of the late Professor Simon Newcomb.

Mr. John Fitz, of Bethlehem, Pa., has been elected an honorary vice-president of the Iron and Steel Institute of Great Britain, under the new by-laws, which permit the election of distinguished foreign members as honorary vice-presidents.

DR. CLEMENS VON PIRQUET, Johns Hopkins University, has been awarded the Goldberger Prize of 2,000 crowns by the Imperial and Royal Society of Physicians of Vienna on account of his discoveries of certain phases of immunity and skin reaction in the diagnosis of infantile tuberculous lesions.

PROFESSOR W. BATESON, F.R.S., has resigned the chair of biology in the University of Cambridge to accept the directorship of the John Innes Horticultural Institution at Merton, Surrey.

DR. R. O. E. DAVIS, formerly associate professor of general chemistry in the University of North Carolina, is now soil physicist in the U. S. Bureau of Soils.

DR. F. R. WHITE, assistant to Mr. David Barrows, director of education in the Philippine Islands, has been appointed to this position as successor to Mr. Barrows.

PROFESSOR M. J. M. HILL, F.R.S., vice-chancellor of the University of London and professor of mathematics, has been elected an honorary fellow of Peterhouse, Cambridge, of which he was formerly a fellow.

MISS E. M. BRESEE, of Madison, who graduated from the University of Wisconsin in 1908 after specializing in chemistry, has been appointed assistant chemist in the department of feed and fertilizer inspection in the College of Agriculture, to succeed Mr. W. A. Brannon, who resigned to accept appointment as assistant chemist to the State Dairy and Food Commission.

CAPTAIN SCOTT, the head of the proposed British Antarctic expedition, has received a letter from Major Darwin, president of the Royal Geographical Society, stating that the council of the society heartily approves of the expedition and will contribute £500 towards the sum needed. The president and council of the Royal Society have also intimated that they will be happy to subscribe £250 from their private funds towards the scientific objects of the expedition.

THE Livingstone gold medal of the Royal Scottish Geographical Society has been presented to Sir Ernest Shackleton, in recognition of his work in the Antarctic.

WE learn from *Nature* that the Royal Society of Edinburgh has presented the Makdougall-Brisbane prize for the biennial period 1906–8 to Mr. D. T. Gwynne-Vaughan for his papers (1) "On the Fossil Osmundaceæ," and (2) "On the Origin of the Adaxially Curved Leaf-trace in the Filicales"; and the Gunning Victoria Jubilee prize for the third quadrennial period 1904–8 to Professor G. Chrystal, for "A Series of Papers on 'Seiches,' including 'The Hydrodynamical Theory and Experimental Investigations of the Seiche Phenomena of Certain Scottish Lakes.'"

LIEUT.-COLONEL D. PRAIN, F.R.S., director of the Kew Botanic Gardens, and Dr. F. O. Bower, F.R.S., professor of botany at Glasgow, have been elected corresponding members of the Munich Academy of Sciences.

MR. A. D. E. ELMER is about to return to Manila with a large collection of plants that he has made in the southern part of Mindanao, from Davao as a base. The botany of this region is entirely unexplored, and something of its richness is indicated by the fact that only two species of oak have been reported from that region while Mr. Elmer finds at least fourteen.

PROFESSOR C. J. BOURNE delivered the Herbert Spencer lecture at Oxford on December 2. The subject was "Herbert Spencer and Animal Evolution."

BY the death of Mr. John Masterson, of New York, at the age of ninety-seven years, a gift takes effect of $4,000,000 which was made in 1902 to provide for poor persons during convalescence.

THE public library and museum at Kilmarnock, Scotland, was destroyed by fire on November 26. The building, known as the Dick Institute, was presented to the town by the late Mr. James Dick, of Glasgow, about nine years ago. The museum contained the geological collection of the late Mr. James Thomson, and a considerable portion of the Braidwood collection of curios which belonged to the late Dr. Hunter Selkirk, of Braidwood. These were completely destroyed. The damage will probably amount to about £50,000.

The Chemists' Club of New York has inaugurated a plan for bringing together the professors of chemistry of the various universities with their former students at the smokers of the club. Saturday evening, November 27, was designated as Harvard Night, to which the professors of that university and the members of the New York Harvard Club were invited as guests. Professors Richards, Torrey and Baxter outlined the lines of investigation being conducted in their respective departments. It is hoped that in future meetings the chemists of New York will have opportunities for coming into contact with the work of the various other colleges in a similar fashion. The finance committee was able to announce subscriptions amounting to upwards of $200,000 to the Chemists' Building Company.

The ninth annual meeting of the American Philosophical Association will be held at Yale University, New Haven, Conn., on December 27, 28 and 29. The subject selected for discussion is: The problem of time in its relation to present tendencies in philosophy. Stop-over at New Haven will be allowed to persons holding tickets reading *via* that point to Boston to attend the meeting of the American Association for the Advancement of Science and the American Psychological Association. Tickets must be deposited at station office at New Haven not later than December 29, and must be withdrawn from deposit in time to reach Boston not later than December 30.

The Sullivant Moss Society will meet in affiliation with the American Association for the Advancement of Science at Boston on Thursday, December 30, at 2.30 P.M. in the hall of the Boston Natural History Society, Berkeley Street. An informal meeting will be held during the morning hours to view exhibits and make acquaintance. The program meeting in the afternoon is open to all and will be followed by a general discussion. For further particulars address Mrs. Annie Morrill Smith, 78 Orange Street, Brooklyn, New York, in whose care all manuscripts, etc., should be sent. Titles and abstracts of papers should be sent in at once to secure place on the program.

The *Standard* for November 22, says *Nature*, contains a full list of the House of Lords, classified according to their qualifications. There are only two names—those of Baron Rayleigh and Baron Lister—under the heading "Scientists," while "Educationists" are only represented by Baron Ashcombe, member of council of Selwyn College; Baron Killanin, member of senate of Royal University of Ireland, and the Earl of Stamford, formerly professor of classics and philosophy at Codrington College, Barbados. There are thirty-five railway directors, thirty-five bankers and thirty-nine so-called "captains of industry" on the list, and a column and a half under "Military and Naval Services."

UNIVERSITY AND EDUCATIONAL NEWS

The Duke family have made a further gift of $500,000 to Trinity College, Durham, N. C., for the establishment of a medical department.

Mrs. Helen Hartley Jenkins has given a considerable sum to endow a fund at Teachers College, Columbia University, providing for a department to instruct trained nurses, who are expected to give instruction on the care of the sick, sanitation, etc.

According to figures available in the office of the auditor, the University of Chicago holds investments representing permanent endowment that aggregate $14,870,903.01. In addition, its buildings and grounds devoted entirely to university use represent $8,917,708.10; equipment, scientific apparatus, furniture, etc., being put at $1,916,314.49 additional. These figures do not include the funds destined for the erection of the Harper Memorial Library, estimated in round figures to cost $900,000, on which work will probably begin next year, nor the cost of the classical building, the construction of which is in contemplation, and on which about $250,000 will be expended.

The University of Brussels has received gifts amounting to $1,300,000.

Emeritus Professor Thomas Purdie has offered to the University of St. Andrews the

sum of £2,000 to provide the salary of an assistant in the Purdie Chemical Research Laboratory.

The Special Board for Moral Science of Cambridge University calls the attention of the senate in a report to the need of more adequate accommodation for the laboratory of experimental psychology. At Oxford an excellent laboratory devoted to experimental psychology has recently been erected. It is estimated that a building adequate for the present needs of the department might be erected at a cost of £3,000, and to this must be added £1,000 for fittings. Towards this amount nearly £3,700 has been already promised or paid, but this includes an offer of £3,000 made on condition that the building is begun without delay.

At Cornell University, the graduate department, hitherto under the jurisdiction of the university faculty, has been reorganized as a separate college under the title of the Graduate School. A research professorship has been conferred upon Professor Titchener, who becomes Sage professor of psychology in the Graduate School.

Among recent appointments at the Iowa State College are the following: W. W. Dimock, B.Agr., D.V.M. (Cornell), associate professor of veterinary medicine; W. M. Barr, B.S. (Iowa, '02), Ph.D. (Pennsylvania, '08), associate professor of metallurgy; Archibald Leitch, B.S.A. (Ont. Agr. Col., '05), assistant professor of animal husbandry; W. H. Pew, B.S.A. (Iowa State, '07), assistant professor of animal husbandry; Ira G. McBeth, B.S.A. (Ohio, '07), M.A. ('08), assistant professor of soil bacteriology; H. W. Gray, B.C.E. (Iowa State, '06), assistant professor of civil engineering; H. E. Ewing, A.B. (Illinois, '06), M.A. ('08), assistant professor of zoology.

Dr. Oscar Klotz, assistant in pathology at McGill University, Montreal, has been appointed professor of pathology in the University of Pittsburgh.

Hamden Hill, A.B., has been appointed instructor in chemistry in the University of North Carolina.

DISCUSSION AND CORRESPONDENCE

INTERNATIONAL LANGUAGE

To the Editor of Science: In order that American scientists may know something more of "Ido" than is given in Professor Jespersen's article in Science of November 12, I quote below a statement of Professor Dr. Förster, who was a member of the International Language Committee referred to by Professor Jespersen, and honorary president of it. This statement is taken from *Germana Esperantisto,* for December, 1908, pp. 138–9. Professor Förster, who was formerly director of the Berlin Observatory, says:

I was a member of the international committee whose duty it was to examine critically the most important hitherto existing systems of international language. The past autumn [*i. e.*, in 1907] this committee recognized Esperanto as the most satisfactory hitherto existing auxiliary language. At the same time, the committee, without an intention of disturbing the essential genius of the language, recommended some reforms, by means of which it was thought to attain a more rapid and general spread of Esperanto.

But the committee, or rather the commission elected by it, failed to secure the absolutely necessary consent of the officials of the already extensive Esperanto organization to their reforms, which the whole body of Esperantists, with very few exceptions, did not consider as improvements.

But instead of consenting that the effort be made to introduce the reforms gradually, in consideration of the natural resistance of such an enthusiastic movement, the commission, going beyond the task given it by the committee, and against the desire of eminent members of the committee, assumed towards the officials of the Esperanto movement a critical air of superiority and attempted themselves to spread a reformed, and even in its external aspect essentially changed language, which they variously called "Ido," "Ilo," "Reform-Esperanto," "Esperanto-simplified," etc., although the Esperantists did not consent to the use of the name Esperanto and although the additions "reform" and "simplified" contradicted the conviction of nearly all Esperantists.

This procedure caused me not only to relinquish the honorary presidency, but also to resign from the committee, for in such proceedings there is lacking, in my opinion, any degree of social wis-

dom, and I find them suitable only for creating confusion, and of putting in danger the progress attained after decades of hard work.

Professor Förster was not the only member of the committee who resigned from it in disgust at the action of the subcommittee. In the *Germana Esperantisto,* No. 8, 1909, Professor Dr. Ad. Schmidt, one of those members who left the committee, speaks very pointedly of the misrepresentations in an article published by Dr. Pfaundler, one of the men whose names were mentioned by Professor Jespersen. Couterat, also mentioned by Jespersen, is editor of the official organ of the "Idists." In a recent number of this journal he prints statements concerning the position gained by Esperanto at the Psychological Congress last summer that, to say the least, are misleading, though in a subsequent number he publishes a very lame retraction.

Since the disruption of the International Language Committee, occasioned by the belief on the part of conservative members that the subcommittee were putting in jeopardy the whole question of an international language, a faction of that committee have continued the propaganda for Ido, a language invented, according to Dr. Schmidt, by the Marquis de Beaufront, one of the most ardent of Esperantists, and a most powerful opponent of changes in Esperanto. Beaufront himself had abandoned his own language because he considered Esperanto superior to it, and, on account of his staunch advocacy of the latter, had been commissioned as the personal representative of Dr. Zamenhof before the language committee. In addition to the faction referred to there are scattered here and there in Europe and America a few opponents of Esperanto who call themselves Idists, Ildists, etc. These gentlemen are not at all agreed as to the structure of their language. Their official organ is devoted, not so much to the propagation of a particular form of international language, as to a learned (?) discussion of what the characteristics of an international language should be, and to an attempt to discredit Esperanto. It is not uncommon for the contributors to this magazine to give, in connection with their articles, a synopsis of the grammatical forms with which at the time they are experimenting. Even the Idists are now beginning to perceive the folly of their course, and are beginning to clamor for a "period of stability," the one thing they have fought most strenuously in Esperanto, and the absolutely essential element of success. Esperantists realize that to open the gate to "improvements" can only end in a wrangle that means certain death to the movement for an international language, which at present has such brilliant prospects.

The writer well remembers when he began the study of German, how many things he found in it that he could have improved. The same was true of French. It is not strange, therefore, that beginners should have a strong desire to "improve" Esperanto. But after two and a half years study of Esperanto, the writer has come very fully to the conviction that the very points in which he desired to see the language changed are the best features of it. After having acquired the ability to read Esperanto practically as freely as English, and the ability to speak it with a fair degree of freedom, the writer is of opinion that, without any changes whatever, Esperanto will make a satisfactory international language. Professor Jespersen refutes his own statement that Esperanto can not be printed in any printing office, by showing in the latter part of his article that this can be done. Since more consonant sounds are needed than there are letters, Dr. Zamenhof chose two ways of representing certain sounds, one with supersigned letters, the other with combinations of letters. Either may be used. Telegrams are sent daily in Esperanto, Professor Jespersen's statement to the contrary notwithstanding. His statement (in Esperanto) that this language lacks many roots is trivial. If he knows Esperanto he knows that in the laws governing the development of the language *any root whatever* can be added by *any Esperantist* whenever needed, the only requirement being that the root shall be adequately defined. If, then, the new root is taken up by writers of repute, it is in due time given formal approval by a committee having full authority. Eight hundred and

seventy new roots were thus approved last year. Others will be added as needed.

In Washington city, during the past week, we have had the opportunity of hearing Esperanto spoken by Professor Arnold Christen, an adept in the language. I have yet to find any one who has heard him speak in Esperanto who does not say with enthusiasm that it is the most beautiful spoken language he has ever heard. Next summer the international scientific association will meet in Washington, and all its deliberations will be conducted in Esperanto. Any one who doubts the sufficiency of the language would do well to attend the meetings of this association.

W. J. Spillman

THE ADVANCE OF INTERNATIONAL LANGUAGE

I have read with interest Professor Jespersen's article on "International Language" in Science for November 13. Professor Jespersen's name and his rank as exchange professor at Columbia University, together with his report on the decision of the International Scientific Committee, may, among many who have not investigated the subject, win credence to the possibility of the advance of the cause of international speech resulting from adopting Ido in place of the more familiar Esperanto.

Inasmuch as I am one of those who helped to elect the International Scientific Committee, which, as Professor Jespersen mentions, announced that Esperanto "might serve as a basis for the international language provided it were thoroughly modified and improved on certain specifically indicated points," I feel that I must decline any responsibility for the actions of that body. I especially deprecate the committee's arrogating to itself the authority to construct and advance a new language system. Aside, however, from the question of the origin of Ido, as scientists should generally be sufficiently broad-minded to accept a thoroughly good thing, no matter what its origin, I wish to call attention to some facts of which we should take note in considering the question of an international language.

Esperanto is not a hypothetical system for international communication, but is a language in actual use, possessing not merely grammars, readers and dictionaries, but a wealth of literature both general and technical in character. It has propaganda journals published in almost every civilized country on the globe, and also a large number of magazines devoted to special subjects, such as medicine, literature, photography, etc.—over ninety periodicals in all. At the present time the most important journal to the scientist is the *Internacia Scienca Revuo* published at Geneva, Switzerland, under the patronage of Dr. Zamenhof, the French Astronomical Society, the French Physical Society and the International Society of Electricity, and the fifth volume, completed in 1908, bears the names of such men as Adelskold, Appell, D'Arsonval, Baudoin De Courtenay, Becquerel, Berthelot, Prince Roland Bonaparte, Bouchard, Deslandres, Flournot, Förster, Haller, William James, Mourlon, Henri Poincaré, General Sebert and J. J. Thompson. It is worthy of note also that technical Esperanto vocabularies for each science are being compiled by specialists from many nations.

In Europe there are Esperanto hotels and Esperanto consulates, and in both Europe and America and even in far-away Japan there are Esperantists in every city of large size and in innumerable small towns. Many business firms in London and Paris as well as in this country are known to the writer as using Esperanto for correspondence and advertising, and it is to be presumed that these represent a very small proportion of the commercial firms having found it advantageous to use this language. It might be added that linotype machines can be equipped with the additional characters for writing Esperanto at a cost of $1.50, and a typewriter can be equipped with the extra characters for less than $1.00; in fact, some of the standard typewriters are made with Esperanto characters without extra charge. Surely it should be as easy also to telegraph in Esperanto with its six supersigned letters as it is to telegraph in French with its acute and

grave and circumflex accents, or in German with its umlauts; but to deal in facts and not in theories, during the past month I have had personal knowledge of important telegrams and cablegrams that had been transmitted in this international language.

International congresses on various subjects are using Esperanto, for statistics on which highly important point I need only refer to page 478 of SCIENCE for October 8; and the Esperantists themselves have tested this language in five successive international Esperanto congresses and have given overwhelming proof of its practicability. The Fifth Esperanto Congress, held last September in Barcelona, Spain, was attended by 1,300 delegates in spite of the unrest prevalent in that city. The sixth congress will occur in the United States next August and will bring proof to our very door, if it be that we still need proof, that the language is musical, remarkably easy, and a success, and after all the main point for an international language is that it should be a success.

Ido, Ildo, Purified Esperanto, Esperantido and Esperido, as it has been variously called, on the other hand, as far as statistics have been obtainable, has less than thirty adherents in the United States, in which list for the present I include Professor Jespersen. The following of Ido in European countries I understand to be proportionately small. It has a few readers and grammars and textbooks and much diatribe against Esperanto, but no literature whatever. It has ten periodicals, including both propaganda and other magazines, a number of which, while attacking Esperanto, have been printed partly in Esperanto in order to reach the public. In this list of ten I am including one little sheet published in the United States and designated a quarterly, though its first and latest issue appeared in April of this year. Ido has had no congresses or similar assemblies before which this proposed system for international communication could be tested. But in addition to returning the Scotch verdict of not proven to the Idists' claims for recognition, I wish to advance certain reasons why I believe Esperanto to be superior in construction to Ido, Ildo, Esperido, etc.

1. Esperanto is more musical, for in cutting out the six supersigned letters Ido and its related systems have been forced to reduce the sounds also; thus a so-called "purification" has resulted in monotony.

2. Esperanto has definite rules and no exceptions, it is in short a logical language, while there are many exceptions recognized as proper to the rules of Ido or Purified or Simplified Esperanto.

3. Esperanto is the most truly international language in several important details, and therefore may be most easily learned by all civilized races, while Ido, or Simplified Esperanto, with its harsh Anglo-Saxon pronunciation of the letter *j*, and its fixed Franco-English word order would prove troublesome to most Europeans. KARL F. KELLERMAN

BUREAU OF PLANT INDUSTRY,
WASHINGTON, D. C.

COLLEGE SOLIDARITY

WHEN ideas that have been in the air are, as it were, precipitated by the utterance of an eminent man in an authoritative position, they suddenly become fructifying and productive of both wheat and tares. If, therefore, solutions both profitable and unprofitable to the college problem were numerous before President Lowell's installation address, they may be expected in increasing numbers to follow his clear and impressive presentation of the needs of American colleges. And indeed, the greatest direct benefit to be expected from this conspicuous discourse must be the incitement it will prove to all intimately interested in our colleges to formulate and publish their convictions as to the best means of meeting needs widely recognized and admitted.

There can be little question that President Lowell is right in his opinion that the passing of the common habitation made necessary by the increased number of students, and the passing of the common curriculum attending the introduction of the elective system, have resulted in social and intellectual disintegration. Further, it will be granted that the old

complete college "solidarity" belongs to the old order and that we shall now have to be content with the intellectual and social cohesion of groups of students. The effectiveness of the method he has suggested for reaching this end is, moreover, reasonably sure. That the segregation of the freshman in class dormitories and dining halls would result in an intensification of class spirit is patent. A class thus centralized and made aware of itself during its first year, would inevitably gain something of social unity and identity. But would the gain be worth the cost to the college and to the individual?

In calling attention to the great educative value of intercourse between classmates far called from all the corners of the country or of the world, Cardinal Newman noted, over half a hundred years ago, that this was not due entirely to the students of the university, but was largely dependent upon the *genius loci.* "Independent of direct instruction on the part of superiors," he said in the sixth discourse in "Idea of a University," "there is a sort of self-education in the academic institutions of protestant England; a characteristic tone of thought, a recognized standard of judgment, is found in them, which, as developed in the individual who is submitted to it, becomes a two-fold source of strength to him, both from the distinct stamp it impresses on his mind, and from the bond of union which it creates between him and others." In several of our American colleges such a spirit is already appreciable, and it is a recognition of its value that influences men and women to send their sons and daughters across the continent, if need be, to our long-established colleges when there are colleges at their doors offering similar academic courses under the direction of men of the highest scholarship, when economy and family affection, and all tangible arguments are in favor of the home college. It is for this that sons are dedicated from their birth to Yale or Harvard, and daughters to Vassar or Wellesley, irrespective of transient administrative policy or the individual members of the teaching force. This subtle but precious power is imperiled by the segregation of the freshman class. If successive incoming classes acquire solidity before they have been subject to the atmosphere of the institution, while they are yet unaware of its standards and traditions, they must soon become incapable of transmitting or responding to the cultivating influence of what is now considered the permanent and inherent spirit of the place, but which must be radically changed in the course of a few college generations whose classes crystallized in the freshman year. To make more effective the influence of this fine, esoteric force in the college world is the real object of gaining solidarity, and if it be lost our solidarity will be to little purpose.

Nor is this the only objection to the segregation of the freshmen. Inexcusable as the practise of hazing seems, it is not with its purpose that we quarrel. No one can have had much to do with young people in America without appreciating the fact that for the sake of the community and for their own sake, many of our youthful collegians should be taught humility of spirit. The isolation of the freshmen would interfere with the accomplishment of this purpose in the most objectionable way. The most natural way to teach freshmen that they are not of so much importance to others as to themselves is to submerge them in a community of older college men. Finding themselves a submerged fourth in a community of men more at home in the college world, they learn to take a subordinate part in the discussions, to listen to the opinions of others, sometimes to accept them, and even to entertain an opinion without expressing it. The self-centered and contentious are snubbed into right-mindedness before they know it. They learn self-control and discrimination. They come into contact with the older men naturally and learn from them. When they are set apart the upper classmen seek them out chiefly to "rush" them for fraternities. The result is that what was a superficial defect of character is driven in, becoming perhaps less manifest but more deeply rooted.

The presence of a few upper classmen or instructors in a freshman dining hall or

dormitory, can not be counted on to offset the evils of segregation. The Edward Bowens and John Henry Newmans, natural leaders of youth, are rare in the educational world, and too often the desire to influence young people and the power to do so are not coexistent. Many of the instructors by whom students desire to be influenced, whose influence they would not resist, wish after class hours are over to live a life apart from undergraduates. Those who, prompted by the missionary spirit or the need of the remuneration offered for this service, accept such positions, are often merely tolerated, and prove a subduing influence, perhaps, but seldom a vitalizing one. Even where intelligence and good will are forthcoming, divergence of interests makes it difficult for an instructor to discuss in a stimulating manner a question brought from the class-room by an interested student. Occupied in his special field, he remembers dimly the political economy, the literature and history, of his college days. Conclusions previously reached may be carefully registered in his brain and these he can pronounce in the dogmatic manner most fatal to discussion; but the facts which led him to his conclusion, and through which the student must be led to it if he is to reach it at all, he has long forgotten. He can not recall the cogent reasoning he employed to convert his classmates to bimetalism when he cast his first vote; he does not remember why he thought Maggie Tulliver nobler than Tom, or on what grounds Jefferson's loyalty to the Colonial Army could be shown to be no violation of his duty as governor of Virginia.

To criticize with confidence an offered solution is a much simpler matter than to offer a solution not open to criticism, but I believe the natural and right way to insure solidarity for large groups of students is through our academic departments rather than through their dormitory life. The only solidarity that is worth working for is one that touches the social life of the students, to be sure, but one that touches it through academic interests—an indigenous, academic solidarity that grows out of the nature of the college and is not independent of it and merely the result of common youth and humanity and propinquity. In the first place, are modifications of the elective system that are responsible for the intellectual disintegration, and so partly for the social, possible?

If we were to take practical measures toward developing the individual student "in his strong and in his weak points," toward training him to know "a little of everything and something well," we should probably impose some restrictions on the election of courses. We should require, perhaps, the selection of a major subject to be studied through the four college years; we should require in addition the election of such subjects as would insure breadth and diversity of knowledge or train the various faculties of the student. A course in English might be required of all freshmen, a science of all sophomores, an introductory course in philosophy of all juniors. Many of our colleges have, in fact, already established just such requirements. This is one step toward the desired end, in that it provides for all members of the class, year after year, a common academic interest and background of knowledge, and constantly brings together large groups of members of that class for lectures and examinations.

Such an arrangement has in it, moreover, opportunities, as yet, so far as I know, unexploited, for what I may call departmental consolidation. Presupposing the existence of this regulated elective system, every student in college must be closely identified with some one department. During his four years' work in the department in which he has chosen his "major," he must come to know and to be known by the head of the department. Thus, every student would come in contact with one of the first-rate members of the college faculty, and their intercourse would be along lines of real interest to them both, where each would be at his best. If, further, the student were required to consult the head or dean of this department with reference to the election of other courses, and if this head or dean were the one to whom his grades in other courses were reported and to whom he must account

for all academic failures, if, in short, he *belonged* to the department in which he took his major subject and felt himself under the supervision of one officially and personally important to him, he could scarcely maintain an attitude of irresponsibility toward academic work.

The making the department the unit of organization would serve not only to bring into more vital relationship the student and teaching force; it could also be made a strong agency in the bringing together students of like interests. It would be a simple matter to have students belonging to the same department take their required work in other departments in the same divisions. That is, members of the zoological department would recite together in required freshman English classes, in required sophomore mathematics, and so on. For elective courses such an arrangement would be difficult to manage and undesirable. The major course and the required courses would sufficiently bring together the members of one department, and the elective courses should give an opportunity for them to become acquainted with the members of the other departments of the college.

It would be at the discretion of the dean of each department to do as much as he wished toward bringing about inter-class sociability within his department through receptions and lectures for all its members. But even should he do nothing, the social integrity of the department could be depended on. As has already been shown, the acquaintance of the members of each class with each other would result from the mechanical fact of common class divisions for recitations. Departmental publications, "shop" clubs, and so on, would bring the members of the four classes together. Departmental pride would come into being, and the older men in the department would take a friendly interest in the new recruits. Having common academic interests and common friends, members of one department would gravitate towards common lodgings. Under such circumstances *esprit de corps* would promote good fellowship within departments, and wholesome rivalry between them.

This plan of mobilizing the forces for culture in our colleges through the academic departments is open to the criticism that it will result in early, and so mistaken specialization and make students narrow. It is also open to the objection that it will greatly increase the burden of the head of the department.

Safe-guards are provided against extreme specialization and consequent narrowness in that a diversity of work and contact between the members of the several departments, are provided for. Even slight contact between students of centralized and developed interest would be more fruitful of reciprocal interest in the personality and in the work of those concerned, than is the helter-skelter mingling of students too neutral, because of diffused interests, to be felt.

Escape from mistaken specialization would of course be possible through transfer from one department to another. There would, however, if the departments were what they should be, be comparatively few of such cases. It is true that students are unable to tell at the beginning of the freshman year for what work they are best fitted; but this is also true for many now at the close of the senior year. In fact it yearly becomes more difficult for me to doubt that "predestination," so far as work is concerned is largely a matter of accident. I once put to Edison the question, "Had your interest chanced to be directed along some other line, do you think you would have succeeded so well?" His reply was, "Hard to say—I should have made an eighteen-hour-a-day try at it, anyway." And for most of us it is the "eighteen-hour-a-day try" that counts more than inherent aptitude. The marked success of workmen engaged entirely without selection, brought William Morris to this conclusion in a field in which natural ability is supposed to be most indispensable. With the rank and file of college students, as with the rest of mankind, want of interest is, in general, due to want of understanding. With the vitalization of academic work that the proposed plan seeks to effect, no student

would be allowed to graduate without a good understanding of some subject; and most of us would concede that it is worse for a graduate to be interested in nothing, than it would be for him to be interested in a subject in which he may not have been intended to be concerned.

As for his future, it will be possible for the student with capacity and opportunity for the highest personal development, to choose vocational work along another line, and his enthusiastic devotion to one subject and the sense of power that its mastery has given him will be an incentive to determined work in a new field. On the other hand, the student who lacks either opportunity or desire to change, will come out at a higher point when he has completed his professional course, than he would had he not acquired in his undergraduate years the power to do steady, intense, purposeful work.

For the headship of departments exalted almost to the position of constituent colleges of a university, it would be necessary to find men of liberal education as well as sound scholarship in a single field, men who could give character and vitality to a department, who could make themselves felt through their instructors, who could impart to students an enthusiasm for work so deep-seated as to enable them to withstand the lure of other departments when interest in familiar work was brought into competition with the charm of initial knowledge in fresh fields. To find the right men for the top places would be difficult, but it is not so impossible as to provide dormitories with successful proctors of the elder-brother type. The head professor would work under conditions most favorable. He would have large authority. The student coming to him in the spirit of willing discipleship predisposed to find his chosen leader wise and right, would receive instruction with open mindedness and respond quickly to suggestion. By limiting his teaching to the students belonging to his own department, the professor could know the stimulus of working in an atmosphere of scholarly concentration with men seriously sharing his interests, an atmosphere sure to promote that most elevating of human relationships, the impersonal comradeship of those who have sunk sense of self in a common quest. Even granted added work for the head professor, he might in the end count himself a gainer through his enlarged responsibility.

F. M. PERRY

QUOTATIONS

SECONDARY EDUCATION IN AGRICULTURE IN THE UNITED STATES[1]

AGRICULTURE, including horticulture and forestry (and it is well to bear in mind that where I use the term agriculture I would use it in the ordinary sense to include the whole subject), should be a regular part of public secondary education; (2) the unity of the educational system should be maintained, but there should be sufficient elasticity of curricula to meet the various needs of the people; (3) the standard curriculum of secondary schools having agricultural courses should conform in a general way to that adopted for the general school system of the state; (4) the standard agricultural courses, whether in the ordinary high schools or in special schools, should not be narrowly vocational, but should aim to fit the pupils for life as progressive, broad-minded and intelligent men and women, as well as good farmers and horticulturists; (5) the standard courses in agricultural secondary schools should be so organized as to form a natural and proper preparation for entrance to agricultural colleges.

The conditions of entrance requirements to colleges are, in my judgment, far from satisfactory. It is not likely that we have reached the ultimate plan for the preparation of the great mass of students who in the future will desire college courses. It seems certain that when the so-called vocational subjects are properly organized and taught in the secon-

[1] From an address by A. C. True, director Office of Experiment Stations, before the Association of American Agricultural Colleges and Experiment Stations at Portland, Ore., August 18, 1909, and adopted by the association as containing a statement of principles which it approves regarding secondary education in agriculture.

dary schools they will be generally recognized as having much pedagogical value. This is especially true of agriculture, which is a subject embracing much of the general human interest. Even under present conditions the agricultural colleges would do well to give credit in their entrance requirements for agricultural subjects properly taught in secondary schools.

The agricultural college should have a definite legal relation to our public school system, and especially to the courses or schools of agriculture of secondary and elementary grades. By this I mean that the state legislatures should take definite action recognizing that agricultural colleges have a definite function to aid in the organization of a proper system of secondary instruction in agriculture, and help the secondary schools in that work.

One difficulty now in the progress of this movement is that in quite a number of states the legislation is such that the agricultural colleges, if they take any part in it, have to "butt in." The whole matter of secondary education is in many states intrusted to the state department of education, as far as the state deals with the matter. I think that ought to be remedied. It may be said that that is only part of a wider thing. I do not believe that we have yet in this country considered definitely enough the proper relation of our universities and colleges to the more elementary education. These higher institutions in many states yet stand too much apart from our general system of education. It is very desirable, it seems to me, that they should be recognized by statute everywhere as an essential part of our system of public education. And while that general movement is proceeding the friends of agricultural education should urge that the agricultural colleges should have a definite part in the organization and maintenance of systems of agricultural education in the public schools.

Agricultural colleges will have to do secondary work to a considerable extent for some time to come. We can not, in my judgment, jump immediately in all our agricultural colleges to a state of things where all the secondary work is excluded. This should, however, be definitely organized as separate and distinct from the college work. The aim should be to have all secondary work relegated to secondary schools, entirely separate from the colleges, when such schools are efficiently organized with reference to instruction in agriculture.

Agriculture should be generally introduced into the ordinary high schools. There should also be a limited number of special agricultural high schools in the different states. These should be so limited in number that they will be organized with reference to large districts. I do not believe it is either necessary or desirable to organize such schools with the county as the unit. Experience so far points to the fact that the county is too small a unit for the proper equipment and maintenance of a thoroughgoing agricultural high school. These special schools have a relatively large agricultural faculty and an adequate equipment, so that students going to them will not only have offered to them a standard course of high school or secondary grade, but will also have opportunity to specialize to a certain extent along different agricultural lines. I believe that such schools are needed, because they will in a way set the pace for secondary education in agriculture, and will help rather than hinder the general introduction of agriculture into the ordinary high schools. Besides serving more general purposes, they will attract a good many of the more mature students, who are not ready or financially able to go to college, but desire to go somewhere to get some definite instruction in agriculture, and who are really too old to feel comfortable in the ordinary high school. These schools will also aid in the preparation of teachers and school officers for the rural schools; so that in a way these special agricultural schools will more fully meet the need which is now being met to a limited extent by the special and short courses in the agricultural colleges.

In speaking of this subject, we must, of course, all the time remember the great extent

which this movement will have when once it is in complete operation. It is a comparatively easy matter now for the colleges to take care of this short-course work and a considerable amount of secondary work, because the number of students so far have been comparatively limited in each state. But as we approach the time when we are to have half a million students in agriculture in secondary schools it is going to be a very different proposition. In the near future the colleges will have all they can do to take care of the students in regular college courses in agriculture. The special agricultural schools will fill a great need by attracting the more mature students who would not go to the ordinary high schools, and the ordinary high schools will have plenty of agricultural students of proper high-school age.

As I said, I believe the standard courses in these special agricultural schools should not be narrowly vocational, but should conform, in a general way, to the general standard for the high-school system in the state, and they should be organized so as to connect them definitely with the general educational system of the state. To do this it will probably be found necessary in the case of schools that have shortened the school year to twenty-four weeks of six days each, instead of thirty-six weeks of five days each, to add another year to the standard course, making it five years instead of four. But it would be desirable that besides the standard courses which would prepare the student for college or for life, as the case might be, such schools should have shorter courses more purely vocational.

SCIENTIFIC BOOKS

Experimentelle Untersuchungen über Atomgewichte. Von THEODORE WILLIAM RICHARDS und seinen Mitarbeitern. Berlin, 1909.

In this fine octavo of 890 pages, Professor Richards has brought together, in German translation, the many papers upon atomic weights which, during the past twenty-two years, have been published by him and his collaborators. These researches are already well known to all chemists who are interested in the accurate determination of these fundamental constants, and the results obtained have received very general acceptance. Their collective publication, however, is highly suggestive, and deserves a careful review.

The first of these researches, that upon the atomic weight of oxygen, was carried on by the late Professor J. P. Cooke, with the cooperation of his then student, Richards. The latter began his independent work with a revision of the atomic weight of copper, which was followed by papers upon barium and strontium. Afterwards, Professor Richards had the assistance of his advanced students, and with their aid the atomic weights of zinc, magnesium, nickel, cobalt, iron, uranium, calcium, cæsium, sodium, chlorine, potassium, nitrogen, sulphur and silver have been redetermined, and apparently with the greatest possible accuracy. There is no reasonable doubt that the work done has been a great advance upon all previous investigations of similar purport; but as Professor Richards would himself admit, it is neither final nor absolute. Our knowledge of physical constants is obtained by what may be called a method of successive approximations; but absolute accuracy is unattainable. The researches now before us represent, in all probability, the closest approximations to the truth as yet reached, but that statement does not imply the impossibility of future improvement. Such improvements are likely to be small, however, and to affect only the minor decimals.

In reviewing the work so far done, one can not help noting the steady advance in experimental technique. The later determinations appear to be of a much higher order than the earlier ones. Indeed, several of the papers in the volume are devoted to improvements in manipulation, or to the exposure of constant errors against which the investigator must be always on his guard. The bottling apparatus in which materials are prepared for weighing, and the nephelometer by which mere traces of precipitates are recognized, represent improvements in apparatus. The purification of

materials is elaborately studied; the errors due to occlusions of gases by metallic oxides, and of water by crystallized salts, are pointed out; and by attention to minutiæ of this kind the accuracy of the determinations has been greatly increased.

In general, with a few exceptions, Professor Richards has confined himself to one group of methods, namely, the analysis, by known processes, of metallic chlorides and bromides. These, in nearly all instances, involve a knowledge of the atomic weight of silver, through which the atomic weights of the other elements are referred to that of the standard, oxygen. That is, ratios are determined, from which, with reference to silver as the experimental standard, the other atomic weights are computed. At first, the secondary standard $Ag = 107.93$, established by Stas, was accepted; latterly, however, it has been shown by several authorities that $Ag = 107.88$ is nearer the truth, and that the true value may even be slightly lower. This change produces corresponding changes in the other atomic weights; a condition of affairs which is not altogether satisfactory. In most cases each atomic weight determined by Richards is a function of the atomic weights of silver, chlorine and bromine, and these have been, in effect, three variables. Theoretically they are constants, but the values found for them have varied, and the variations are far reaching in their effects. The great exactness of Richards's work is in the measurement of definite ratios, which, once established, form the basis upon which our knowledge of the atomic weights must stand. As the variations in the reference values diminish, the accuracy of our deductions will increase.

From one point of view it is well that the Harvard chemists should have devoted themselves, not exclusively, but in great part, to one group of methods. Those methods have been perfected, their sources of error have probably been reduced to a minimum, and the measurements made with their aid leave little to be desired. Considered more broadly, however, it is desirable that other, radically different methods should be developed with equal thoroughness. Not until that has been done, not until closely agreeing determinations of atomic weights have been made by several distinct reactions and processes, can we regard these constants as sharply established. Work of this sort, especially with reference to the more fundamental atomic weights, is now going on in several laboratories, among which may be mentioned that of Guye, at Geneva. Within the next ten years our knowledge of the atomic weights is likely to be greatly increased. Meanwhile, the work of Richards and his colleagues must be assigned preeminence.

F. W. Clarke

Elemente der Exakten Erblichkeitslehre. By W. Johannsen. Deutsch wesentlich erweiterte Ausgabe in fünfundzwanzig Vorlesungen. Jena, G. Fischer. Pp. vi + 515. Gebunden, 10 Marks.

The epoch in evolutionary study opened by deVries's "Mutationstheorie" had been one not only of experimentation, but also, fortunately enough, of thoroughgoing analysis. We had analysis of evolution in sufficient amount, even *ad nauseam,* in the latter part of the last century; but the newer speculations are based on novel, experimentally acquired facts, and the marvel of it is that they bear little resemblance to the conventional and orthodox teachings which we accepted almost without question a decade or two ago. It is to the shame of biological science that it must be acknowledged that it was long contented to accept these speculations as fundamental principles without testing them experimentally. But all that is now happily by and the era of framing hypotheses for the purpose only of testing them is well launched.

Of the old ideas, those grouped about variation have undergone, perhaps, the completest analysis. And they needed it too, for if one thing is clearer than another, it is that Darwin and his followers did not analyze the phenomena of variation satisfactorily. It is almost pathetic to see in his letters and books how he fails to distinguish the fundamental differences between fluctuating non-inherit-

able variations and such characters as serve to distinguish one kind of poultry or mammal from another. To-day we see more clearly that a new character, such as "angora" hair or an extra toe, belongs to a different category of variations from ordinary fluctuations in the length of the hairs on the body of a cat and variations in the thickness of a toe; for a hair will be more or less long according to the nutrition it receives at the base (and this varies at different times), and the toe will be more or less thick, depending on the use to which it has been put. The variations dependent on environment or use are, so far as we know, not inherited, while the new characters clearly are. Thus the primary classification of variations is based on their heritability. This much was pre-deVriesian.

The new viewpoint, introduced by deVries, and extended by Johannsen, affects the interpretation of those slight variations that seem to be independent of environment and are distributed about a mean value in the form of the familiar "frequency polygon." The biometric "school" laid stress on this sort of variation, and held that by selective breeding from the extreme variants through many generations an indefinitely wide departure from a starting point might be effected. This deVries denied, but held that, while such selection might lead to a certain departure from the mode, the degree of such a departure was restricted through a strong regressive tendency. Here Johannsen steps in, analyzing more completely this result of breeding from the extremes of the frequency polygon.

The fundamental principle of Johannsen is that an ordinary frequency polygon is usually made up of measurements of a characteristic belonging to a non-homogeneous mass of individuals; that it is really analyzable into several elementary masses each of which has a "frequency polygon" of its own. In each elementary polygon the variation is strictly due to non-inheritable somatic modifications, selection of extremes of which has no genetic significance. But the selection for breeding of individuals belonging to *different* elementary polygons, lying, say, at the extremes of the complex, may quickly lead to an isolation of these elementary polygons, the constituent individuals of which reproduce their peculiarities as distinct elementary species. Thus Johannsen holds that not only do individuals with qualitatively dissimilar characters belong to distinct elementary species, but often such as are only quantitatively unlike. The complex variation-groups are called by the author *phænotypes*, or false types, the elementary variation groups are *genotypes*, or genetic types.

What is the proof of the existence of these two types? It lies in the author's experiments in breeding "in the pure line." Whenever, in a self-fertilizing species, a character is measured through successive generations it does not show a regression toward the mediocre position of the entire population, but regression occurs only to a near-by mode of the elementary genotype. In such a species regression to mediocrity occurs only when we consider the offspring of parents which, even though similar, belong to distinct genotypes. For, since genotypes overlap, the parents, though quantitatively similar in any organ, may have children that regress in an opposite direction to the modes of their (unlike) genotypes, and thus be quite dissimilar to their parents. In the long run the change from parents to offspring will be in the direction of mediocrity. This is the usual result and it has obscured the facts of genotypes in the midst of, and as constituents of, the phenotypes. Now, although self fertilization is necessary to the *proof* of the existence of genotypes, such types are believed to be universal and necessary to the interpretation of heredity and evolution. So the author in his 500-page book rewrites the science of heredity from the new standpoint.

The book is in the form of twenty-five lectures. The first six are devoted to variability and its statistical analysis; then follow five devoted to selection and regression; three to aberrant and complex frequency polygons; four to correlation; two to types of variation; one to effect of environment; two to hybridization; one to nutrition and one to human

heredity and the theory of the determiner. The field is well covered.

Of the sections dealing with variation and selection it may be said that they contain the sharpest analysis yet made of the biological significance of the variation polygon and of its modification under diverse ancestry and environmental conditions. Considerable space is devoted to the interpretation of skew curves, indicating that, for organisms at least, they are not due to an inequality of the plus and minus selective forces but rather are a necessary consequence of an initial inequality of growth combined with the law of *proportional,* as contrasted with absolute, increments. As to selection, the results of extensive experiments, of which the details are given, indicate that selection can not create genotypic differences. Among abnormal frequencies, bimodal polygons receive fullest attention and several causes are deduced, such as: presence of two races, of two age classes, of two environmental conditions, of dimorphism and of mendelian segregation. In treating of correlation tables the author reaches the conclusion, now generally accepted by modern workers in heredity, that, while useful for many purposes, such tables are useless in the study of heredity in the strict sense.

The general effect of the prolonged argument of the author is to arouse enthusiastic acceptance of the principles he works out, which, indeed, seem in the line of necessary development of modern ideas. Every breeder of experience must have noticed the fact that even trivial, often quantitative, differences may be inherited as unit characters and persistently refuse either to blend or to regress. Such are the genotypes of our author. Nevertheless, the body of heredity data is still so small that we may well hesitate to accept in any other spirit than as a working hypothesis the principles of Johannsen. If it should prove to be possible, in a case where the existence of a biotype-complex can be excluded, to pass by "selection" from one genotype to another, then the value of the hypothesis would be greatly diminished. To this test several scientific breeders are devoting their energies and we shall soon have more data on the matter.

CHAS. B. DAVENPORT

SPECIAL ARTICLES

THE ACTION OF RADIUM SALTS ON RUBIES

IN 1906, Marcellin Berthelot[1] found that crystals of amethyst from Brazil became decolorized when heated to 300°, but that on exposing the decolorized crystals to the action of radium chloride, contained in a sealed glass tube, the original color was regained in the course of a few weeks, owing to the reoxidation of the manganese salt. He suggested that the color of amethyst, and possibly of some other precious stones, may be due to the action of radioactive substances while the stones lie buried in the lithosphere.

The following year Bordas[2] reported that when a blue sapphire is exposed to the action of radium bromide of activity 1,800,000, the color changes to a green, then to bright yellow, and finally to a deep yellow. Under the same conditions, a red sapphire was found to change through violet, blue and green to yellow. Bordas stated that the intensity of the reaction can be varied by altering the distance of the stone from the radioactive salt, or by employing radium bromide of different activity; and concluded that since yellow sapphires are the most common, and blue and yellow ones are frequently met with together, it seems probable that the soil in which these precious stones are found is radioactive, and that the stones are undergoing a very slow change analogous to that he observed. Later[3] Bordas observed that by bringing a tube of radium bromide of very high activity (1,800,000) into direct contact with a corundum, and varying its position every few hours, the coloration can be effected evenly in some days. It was ascertained that colorless corundums can be rendered yellow, and the color of natural topazes and faintly colored rubies intensified in color. Artificial rubies were found to be similarly affected.

[1] *Compt. rend.*, 143, 477.
[2] *Compt. rend.*, 145, 710.
[3] *Compt. rend.*, 145, 800.

About the same time Daniel Berthelot[4] published a statement concerning the changes which specimens of certain minerals, placed by Marcellin Berthelot in November, 1906, in the neighborhood of radiferous barium chloride, had undergone in a years' time. It was found that a colorless quartz from la Gardette and a white, cleavable fluorspar were unchanged; that a violet, amethystine quartz (containing manganese) from Uruguay, which had been previously decolorized by heating, was recolored; and that a violet fluorspar from Weardale (Durham) had behaved similarly.

Later Bordas[5] observed that the coloration of crystallized alumina by exposure to radium bromide is not due to the action of the α-rays, since these were absorbed by the glass envelope containing the bromide; but that the γ-rays are operative in this respect, for colorless corundum becomes distinctly yellow after forty minutes, and topaz colored after several hours' exposure to the action of the Röntgen rays, and these rays are analogous to the γ-rays of radium.

On April 5, 1909, the writer received several crystals of ruby from W. P. Dewey, of Los Angeles, Cal. Two of these specimens were placed in radium chloride of 7,000 activity; one in a tube containing radium chloride of 7,000 activity, in order that the emanation would act upon it; and several in a box containing radium of the same activity. These were then set aside in the dark, and examined recently after six months' exposure. No change in color was observed, and the specimens were entirely unaffected.

CHAS. BASKERVILLE
COLLEGE OF THE CITY OF NEW YORK,
November 12, 1909

[4] *Compt. rend.*, 145, 818.

[5] *Compt. rend.*, 145, 874.

DEMONSTRATIONS OF ELECTRICAL OSCILLATIONS

THE production of high-frequency oscillations from arc or spark has become such a simple matter that the use of the experiments described by Professor Huff in SCIENCE for November 12 is strongly to be recommended, especially as demonstrations before classes in alternating currents. With extremely simple means one can exhibit to an almost extravagant degree some of the effects of alternating currents which at commercial frequencies either do not appear at all, or only with the aid of more costly apparatus.

In this connection the following notes may be of service:

1. Steadier and more rapid oscillations are attainable with the metallic arc than between carbon electrodes. The iron arc in free air gives good oscillations, especially when capacity and self-inductance are so adjusted that the note is a shrill squeak.

2. Many commercial condensers show well the phenomenon of the "musical capacity," *i. e.*, the production of a musical note synchronous with that in the arc. The arc should be placed at a considerable distance from the condenser.

3. Simon's "speaking arc" is shown with a pair of flaming arc carbons and 220-volt supply, making the arc as long as possible. Connect in parallel with the arc a capacity of from 1 to 5 m.f. and the secondary of a small transformer. The transformer primary is in series with a battery and telephone transmitter capable of carrying an ampere. After a little experimentation the arc can be made to reproduce sounds audible throughout a large room.

4. Should the arc go out accidentally, it may be found that the transformer continues to reproduce the sounds, illustrating the "speaking transformer."

5. Some effects at much higher frequencies can be shown by means of the type of discharge recently described by the author.[1] When a discharge at about one tenth of an ampere is passed between metallic terminals in illuminating gas, or better in a mixture of hydrogen and acetone vapor, oscillations of the order of a million per second are generated without the aid of capacity or self-inductance

[1] *Am. Jour. Sci.*, September, 1909, p. 239. *Phys. Zeitschr.*, September 15, 1909, p. 623.

in parallel with the arc. Besides the usual experiments, the existence of a large number of harmonics may easily be shown by means of resonance. The current in the neighborhood of the discharge is much greater than that taken from the mains, owing to the conversion of direct-current into alternating-current energy. For these experiments an e.m.f. of at least 400 volts, alternating, or better direct, is necessary.

WALTER G. CADY
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SOCIETIES AND ACADEMIES

THE AMERICAN PHILOSOPHICAL SOCIETY

Halley's Comet: C. L. DOOLITTLE.

The return of Halley's comet in 1910 has naturally been looked forward to with great interest by astronomers and others. For the purpose of encouraging investigation of the circumstances of its return, a prize of 1,000 Marks was offered by the *Astronomische Gesellschaft* in 1904. A very complete discussion of the available data was carried out by P. H. Cowell and Andrew C. D. Crommelin, of Greenwich. It has been referred to in various places under the motto, "Isti mirantur stellam." The prize was awarded to this discussion.

As soon as the region where the comet was expected to be found had emerged from the sun's rays in 1908, search was undertaken, photographically, in this country and Europe. This was continued until the sun's rays again interfered, but without result. On resuming the process during August of the present year, impressions were found on several plates, the first to achieve success being Dr. Wolf, of Heidelberg. He first detected the image on a plate taken August 28, but did not venture to announce his discovery until September 11. Two plates were taken at Greenwich on September 9. At first nothing was found on either, but a reexamination afterwards showed faint images of the comet on both. It is barely possible that a reexamination of the plates taken last winter may show faint images of the comet, but nothing has been announced up to the present time. It is now easily visible with the 18-inch telescope of the Flower Observatory. The ephemeris of Messrs. Cowell and Crommelin at the time of discovery required a correction of 25 seconds in right ascension and 4 minutes in declination, which must be considered remarkably satisfactory when we remember that the last observations at their disposal were made nearly seventy-four years ago. The time of perihelian passage, given in this discussion, seems to require the correction of 3.4 days, which makes the date April 20, 1910. Another examination of this point gives for the date April 18.63. The nearest approach to the earth will be May 19, distance about 14,000,000 miles, but it will then be so near the sun that it will probably not be visible. On May 18.14, Greenwich mean time, the earth and the comet will be in heliocentric conjunction. It is not unlikely that, on this date, the earth will pass through the tale of the comet. The date when it will be visible to the naked eye is quite uncertain, but probably it will be bright enough for this purpose some time during February, when it will be seen in the western sky after sunset. Toward the end of March, after passing the sun, it appears in the morning before sunrise, reaching its greatest apparent distance from the sun early in May. Toward the middle of May, it again passes the sun and reappears in the evening sky.

Halley's investigation of this comet forms an epoch in astronomical history, but it must be confessed that considerable courage on his part was required to make the prediction of its return in 1759. Probably if he had been aware of the uncertainty attending the identification, depending on the period alone, he would hardly have ventured to make it. Examination of ancient records indicates a succession of visits, extending back to 240 B.C., with the very considerable range of a little more than five years between the longest and shortest period. With such a range some of these supposed appearances must be regarded as resting on rather slight foundation. A committee appointed by the Astronomical Society has formulated a plan for keeping the comet constantly in view, by interesting a series of observers, so placed in latitude and longitude that the comet shall never be lost sight of. A series of photographs, taken in this way, giving a continuous history of the comet, should go far toward solving a number of problems connected with the physical behavior of these bodies.

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 461st meeting was held November 13, 1909, with President Palmer in the chair. The following communications were presented:

The History of the Mule-footed Hog: W. J. SPILLMAN.

The mule-footed hog differs in no important particular from the common breeds of swine save in the solid instead of cloven hoof. The foot character is probably made by the coalescence of the ungual phalanges. The metacarpals, basilar phalanges and middle phalanges are separate as in ordinary hogs. The claim of breeders that the mule-foot possesses hog cholera immunity is not borne out. Four such hogs at Indiana University died after exposure to this disease. The writer had gathered, though from study of but few specimens, that the foot character is on the whole disadvantageous, especially in heavy hogs. The breed is widely distributed in the United States, especially in the middle west and south, and two breeding associations for the registration of mule-foots have been formed. Evidence at hand indicates that solid-hoofed hogs have come down from ancient times, and perhaps the character has been found in certain strains of hogs since these animals were first domesticated.

In crosses between mulefoots and ordinary breeds the mulefoot character is more or less dominant. Some mixed-bred hogs have at birth solid hoofs which split apart usually at about nine months of age, and in some the rear toes split apart, while the front toes remain solid through life.

A Phylogenetic Tree Adapted for Use in Schools: W. P. Hay.

Professor Hay distributed large cards on which were printed botanical and zoological phylogenetic trees. The groups were illustrated by figures of a typical animal or plant with the enlargement or reduction indicated, and the figures of microscopical forms indicated by enclosure in a circle. He explained his use of the trees in teaching, and called attention to their defects and limitations as an expression of relationship. The subject excited general discussion.

The Migrations and Recent History of the Eskimo Curlew: W. W. Cooke.

The Eskimo curlew is almost extinct. Two were shot August 27, 1908, at Newburyport, Mass.; a few were reported by Dr. Grenfell on the Labrador coast the fall of 1906; Bigelow spent the entire fall of 1900 on this coast and saw only five birds and heard of about as many more. The last previous record in the United States is that of two at Nantucket, Mass., August 18, 1898, and the last specimen known from the interior of the United States was taken by Paul Bartsch at Burlington, Ia., April 5, 1893.

Yet this species was once exceedingly abundant. All writers from Cartwright in 1770 to Coues in 1860 testify to their enormous numbers in fall migration on the Labrador coast. Packard in 1860, speaks of a flock a mile long and a mile wide.

The Eskimo curlew had an elliptical migration route; it nested on the barren grounds of Canada, went southeast to Labrador and Nova Scotia, then straight south across the Atlantic Ocean more than 2,000 miles at a single flight to the Lesser Antilles and South America; it wintered on the pampas of Argentina and in spring went north by way of Texas and the Mississippi Valley in a narrow belt on both sides of 97°.

It retained its former abundance until the late seventies or early eighties and then in about ten years the species became almost extinct. Some of this diminution is probably due to the fact that during these years the part of the Mississippi Valley through which it migrated was largely brought under cultivation. But the most potent factor has been the changing of its winter home—where it spent one half the year on the pampas of Argentina—from sparsely settled grazing lands to enormous wheat lands. During the years 1878–1892 Argentina increased its wheat production fifty-fold and the pampas-loving Eskimo curlew suffered.

M. C. Marsh,
Recording Secretary

THE AMERICAN CHEMICAL SOCIETY
NORTHEASTERN SECTION

The ninety-fourth regular meeting of the section was held at the Twentieth Century Club, Boston, on October 22. Dr. W. D. Harkins, of the Massachusetts Institute of Technology, in an address upon "Smelter Smoke" described the nature and extent of the damage done by arsenic and sulphur dioxide emitted from the large copper smelters of this country, and commented on the various methods which have been tried for lessening these evils.

Dr. G. S. Forbes, of Harvard University, presented a paper upon "The Relation between Wave-lengths of Light and Photo-chemical Action." After summarizing the most recent experimental work in this field and stating the theoretical deductions, the speaker dwelt upon the vast opportunity for investigation offered in the study of the rôle of light in bio-chemical reactions.

K. L. Mark,
Secretary

SCIENCE

Friday, December 17, 1909

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of Science, Garrison-on-Hudson, N. Y.

ATMOSPHERIC ELECTRICITY [1]

The industrial application of electricity for light and for power began about thirty years ago. There were then no schools or laboratories in which applied electricity was taught. The science or profession of electrical engineering did not exist. Electricity was taught as a part of the physics course in schools or colleges and, incidentally thereto, brief descriptions of its application to telegraphy were included. Electroplating, the electric arc and electromagnetism were studied chiefly from books and sometimes illustrated with such instruments and apparatus as were to be found in the apparatus collection.

When, however, the great growth or expansion began, about thirty years ago, courses in electrical engineering were gradually added in some of the schools, usually in conjunction with the teaching of physics, to which the new study was most closely allied. The physics department of Princeton under Professor Brackett was among the very earliest to provide instruction in what was in fact the incipient stage of the now highly developed and important science of applied electricity. Those in the field whose memories carry them back to that early time, will easily recall the important contributions made by Professor Brackett and his department to the development of the infant science. On this present occasion Princeton is to be congratulated on the opening of its magnificent new laboratory, the generous gift of Mr. Palmer, which assures the possibil-

[1] Address at the formal opening of the Palmer Physical Laboratory at Princeton University, October 21, 1909.

ity of continued growth and usefulness, in larger measure, in those sciences to the study of which it is devoted.

As a part of the commemorative exercises at this formal opening of the Palmer laboratories, I have been requested to address you upon some topic connected with physics and electrical engineering. Out of a number of subjects which suggested themselves I have chosen "atmospheric electricity"—a subject which permits of a treatment not too technical and which more or less concerns us all. Its relation to the science of physics is evident, and as to electrical engineering, we electrical engineers are sometimes made to experience a wish that it were not so closely related, for, under certain conditions it is perhaps the one thing which menaces in a high degree the integrity of the delicate contrivances which make up an electric installation; interfering most unexpectedly with continuity of service.

I hope that in what I shall say on the subject my physicist friends will bear with me, for I realize that there is little of novelty that I can present. I can but emphasize what I believe to be correct views and treat the matters discussed very generally, if not popularly. While my attitude towards the subject itself has always been that of a learner, it has often fallen to my lot to exert myself to provide means for the protection of electrical installations from such damage by lightning storms as would involve great inconvenience and perhaps heavy monetary loss. The engineer must produce things that do the work and often the need is immediate and compelling. The student of pure science is under no such stress.

From the remotest times the thunderstorm has been one of the most impressive of natural phenomena, inspiring terror in men and other creatures alike. The realization of its interest and grandeur is probably of comparatively modern origin. It is indeed not surprising that in pagan mythology the lightning stroke was ascribed to the anger of the greatest of the gods. It is no wonder that, in one of the greatest poems of the Bible, Job is asked, "Canst thou send lightnings that they may go and say unto thee, 'Here we are'?"

With the decay of authority and miraculous interpretation of natural phenomena and the gradual growth of rationalism and scientific study the recognition of the lightning and the thunder as a result of natural processes gradually came about. In the seventeenth century began that gradual awakening to the possibilities of the conquest of nature, the outcome of which is modern science with all its great achievements. It was the period of Bacon, Galileo, Gilbert, Descartes, Newton and others. At first the explosive action of lightning, the noise of the thunder and the subsequent strong smell of ozone, which often exists, suggested a kinship with gunpowder, or, that certain nitrous and sulphurous constituents of the atmosphere supposedly had become fired. This naturalistic view even the self-constituted witchcraft exponent, Cotton Mather, willingly adopts in one of his books.

Priestley, the discoverer of oxygen gas, in his "History of Electricity," published in 1767, makes an interesting quotation from a paper of a certain Dr. Wall in the *Philosophical Transactions*. This Dr. Wall, an experimenter in electricity in the latter half of the seventeenth century, and a contemporary of Otto Guericke and later of Newton, after describing his experiments with rubbed amber and the production of light and the cracklings therefrom, says, "Now, I make no question but upon using a longer and larger piece of amber, both the cracklings and light would be much

greater." Then further he says: "This light and crackling seems in some degree to represent thunder and lightening." I believe this to be the first reference to the possible relationship between electricity and lightning. The later history of Franklin's suggestion of identity, D'Alibard's experiment and that of the famous kite furnishing experimental proof, are too well known to be dwelt upon here.

The practical genius of Franklin led him at once to the suggestion of protection from lightning by means of a conducting rod of metal, well connected to the moist ground at its lower end, and projecting beyond the highest parts of the building or structure to be protected. In these later years it is not unusual to meet with statements of discredit or denial of the efficacy of this simple device. There seems to be a tendency among the uninformed to regard it as an old-fashioned and useless if not a dangerous contrivance. Often the question has been asked whether it is not an exploded notion that such rods have any value for protection. It may well be that the "lightning-rod agent" of former times is largely responsible for the distrust. He was a sort of confidence man, who supplied a sham appliance, often of marvelous makeup. A structure of twisted metal tube topped with glittering gilt points in clusters, mounted on green glass insulators, the whole as extensive as the unhappy victim could be frightened into paying for, was erected, and often left without any adequate connection to the ground. It was a tree without roots; lacking, in fact, the most essential part of its structure.

Let us add with emphasis that the Franklin rod when properly installed undoubtedly secures practical immunity from lightning damage. Its installation is an engineering undertaking demanding study of varied conditions and proper care and judgment in meeting these conditions. The one consideration originally left out was that if there were any better or more direct paths for lightning existing in the building or structure or better ground connections than the rod possessed these must be included in the protective system. But it is also a fact that the construction of most modern buildings, particularly in cities, involves so much metal in roofing, ventilating and other pipes, wires and the like, that it is generally unnecessary to resort to any separate means for protection.

In cities there are many lofty structures framed in steel, piping that projects above the roof, and metal stacks, generally in good connection with the underground pipe systems; all of which together tend to minimize danger from strokes of lightning. The best vindication of Franklin will, however, be found in the fact that the firmest reliance is placed by the trained electrical engineer upon the provision of an easy path for the electricity of lightning to reach the ground. Practically all his protective appliances or arresters used in electric systems are based on that principle, with modifications and additions to suit particular conditions of use. To provide such modifications and adaptations is by no means an easy task. There is still a possibility of insufficiency such that the menace of breakdowns and damage by lightning still remains a *bête noir* to the engineer. The tremendous discharge of energy possible in a lightning stroke may be sufficient to defeat our efforts. Breaking through insulation and causing short circuits, burning of wires and rupture of circuit, and damage to apparatus are still occasional experiences in spite of our safeguards. Even at a considerable distance away a stroke of lightning, by its inductive action may set up electric waves or surgings which require to be provided against.

The extremely uncertain value of the effects, the irregularity and impossibility of calculation or prediction, render the problem of protection difficult. The effects of these secondary surges are generally incomparably less violent than direct strokes, and they are seldom dangerous to life.

So long indeed as our electric lines are extended above the ground, so long must this disturbing factor be reckoned with. Fortunately it has been possible by constant effort and study to secure more and more effective appliances so that the lightning menace grows steadily less. Research and experimentation in this direction have constituted an important part of the development of electrical engineering.

Having thus at some risk of your patience vindicated our earliest worker in the study of atmospheric electricity—Franklin—let us turn from the practical issues and consider the electricity of the air from a more general standpoint.

The study of the nature and origin of electrical storms or disturbances throughout the atmosphere is of much interest; our knowledge is yet meager; there is much more yet to be learned in this fascinating field. Exploration of the electrification of the air at varying heights by captive balloons, by kites and upon elevations of land, has generally shown an increasing electric potential upward from the earth, and usually positive in relation thereto. Sometimes this relation is reversed. It has been roughly estimated that if the differences noted can be assumed to be extended to include the total depth of the atmospheric layer, the earth's surface might be negative to the surrounding space, 150,000 volts more or less. This condition would not admit of being regarded as constant or stable, since widespread electric storms occur in both our upper and lower air levels. In the highest regions of our atmosphere they take the form of diffuse discharges as in a high vacuum and are called auroras. They either accompany or give rise to magnetic storms, which affect the direction and intensity of the earth's magnetism temporarily, and hence disturb the compass needle, sometimes through many degrees. Within a few weeks past we have experienced such a storm of a remarkable intensity; sufficient in fact to cause interruptions to telegraphic and cable transmission during several hours. Brilliant auroras were at the time seen in some places.

The frequency of auroral phenomena, and perhaps also to some extent the frequency of thunder-storms, seems to keep pace with the sunspot period, at least in our latitudes. At times of sunspot activity, the surface layers of the sun, upon the energy radiated from which so much of earthly activity depends, are stirred by great storms, or immense cyclones of hot gas or metallic vapors; storms seen as dusky spots on the sun's disc. They can attain enormous size—20,000, 30,000 or even 50,000 miles in diameter, though these dimensions are exceptional. They are visible, as is well known, not because they are non-luminous, but because they are less luminous than the surrounding solar surface. In like manner bright spots or faculæ may also be seen, because they are on the whole brighter than the sun's surface adjoining them.

There is much reason to believe that, in accordance with suggestions made many years ago, these solar storms are accompanied by exceptionally vigorous projection outward from the sun to immense distances, of streams of electrified matter. Should the earth happen to be in a position to be swept by such a stream, an aurora may be produced. During a total solar eclipse the so-called coronal streamers are seen to extend from the sun's surface to

distances of upwards of two millions of miles or possibly farther than that, but doubtless they keep on outwardly, and invisibly, to relatively enormous distances. It is not unreasonable as a hypothesis to imagine that they may extend at times as far as the orbit of the earth and may, if the direction is the proper one, reach our outer air.

Further, if they consist of electric ions or particles conveying electric charges, an aurora may result. Dr. Hale, of Mt. Wilson Observatory, has indeed recently shown by the spectroscope that great solar storms are in fact attended by the motion of electric ions at enormous velocities. The phenomena of auroras present peculiar difficulties in their study, since, as in the case of the rainbow, no two observers at a distance from each other see the same or identical appearances. Hence attempts to determine the height by triangulation at which auroras exist give most contradictory results, for it is impossible to fix upon any condensation or streamer which may not be displaced or absent to another observer some distance away. This is understood when we bear in mind that the luminous appearances are not located in one plane, but are distributed in space; condensations of light being the result of superposition in the line of observation.

I have come to the opinion that the auroral streamers often extend in a general direction outwardly from the earth, sometimes to very great distances relatively to the known extent of our atmosphere. The effects observed appear unaccountable upon any other supposition, while they are consistent with the idea of outwardly directed streams of great extent. In April, 1883, there occurred an aurora which was at its maximum a little after midnight. It was the most magnificent display of the kind, which, in spite of a continual vigilance on my part, it has been my fortune to witness. It was upon such a scale that, so to speak, the mechanism of the streamers stood revealed. At that time I could not avoid the conclusion that the auroral streamers must have extended outwardly several thousand miles. There is no space here to present the argument involved. Perhaps the most significant fact is that precisely the same general appearances were noted in Chicago as in the east, and that they occurred simultaneously. The interesting question arises, does the earth temporarily acquire streamers similar in nature to the solar coronal streamers? The answer is as yet unknown. At the time of the great display mentioned there was a sunspot near the center of the sun's disc of about 50,000 miles in diameter. During that disturbance long telegraphic lines could not be operated, owing to arcing at the keys which prevented interruption of the circuits. Apparently in subtle sympathy with its master orb, the sun, the earth's electric and magnetic equilibrium was for a time profoundly disturbed.

While it is by no means certain that auroras and magnetic storms are always dependent on solar outbursts, it is now generally recognized that the observed coincidences are too frequent to be the result of chance. It is perhaps safe to assume that although solar storms and sunspots can occur without provoking auroras or magnetic storms here, it may be doubted if these latter occur on any great scale unless solar activity is coincident therewith. And it seemingly is true that only when the projected electrified matter actually reaches the earth or comes near enough to inductively affect its electrical equilibrium are the terrestrial phenomena produced thereby.

It has even been suspected that a greater

frequency and severity of thunder-storms in our lower air accompanies the active period of the sun or sunspot maximum. This is a hypothesis which would require a careful collection and comparison of data over a long period to give it status as a scientific fact or wholly to disprove it. Be that as it may, experience with lightning damage in electric installations seemingly supports the idea, and led me in a paper given some seven or eight years ago during the minimum period, to predict a severe ordeal a few years in advance. As a matter of fact the prediction was to a large extent verified with the result of extraordinary activity in devising safeguards from which the electrical engineering art now benefits. In general the harm done by thunderstorms is due directly or indirectly to the heavy spark discharges called lightning flashes or strokes of lightning.

It may be of interest to refer briefly to the conditions existing in a cloud which is the source of such destructive energy. As is well known, clouds consist of fine water particles suspended in the air. When frozen these particles are crystalline like minute snow crystals. All clouds above the snow line are likely to be of that character. At a temperature above freezing the particles of water are microscopic spheroids which may by gradual coalescence form drops of rain. This process of coalescence necessarily diminishes the total surface of the water existing as such in the cloud. Should, however, the original particles possess even a slight electric charge, the union of the drops, by lessening the total surface, or diminishing the electric capacity, results in a great rise of potential or electric pressure on the surface of the drops. The process of coalescence continues and the water falls out of the cloud as rain. If the cloud particles are frozen the diminution of surface and consequent increase of electric pressure can not take place. This would seem sufficient to account for the general absence of thunder-storms in winter, though perhaps other causes contribute.

A thunder-cloud has been compared to an insulated charged conductor, such as a body of metal hung upon a silk cord, but in reality the two are not at all comparable. It is a mistake to assume any close analogy to exist. The cloud being only an air body containing suspended water particles, is not a conductor, nor can it, as in the case of metal, permit the accumulation of its electric charge on its outer surface. In fact it possesses no true definite outer surface but blends with the clear air around it. The electric charge it possesses remains disseminated, so to speak, throughout, and must reside chiefly upon the surface of its constituent water drops. Accumulation in any part would require the insulating air between the drops to be overcome.

A lightning stroke from such a mass may indeed represent a discharge of hundreds of amperes at millions of volts. We must, however, be cautious not to exaggerate either the current or the potential present in a lightning flash. The current in a flash can at times be only a few amperes or may in the heavier discharge reach perhaps hundreds, or possibly in extreme cases some few thousands of amperes. It is doubtful if the potential much exceeds at any time more than a few millions of volts as it is probable that small local breakdowns start the disruptive process which then extends through miles of length. The individual water particles even when collected into drops can not be charged to such enormous potentials as millions of volts. In reality it is the combined effect of the numerous particles act-

ing inductively that accounts for such pressures. A combined stress is set up towards the earth or towards another cloud mass of opposite charge. The lightning stroke results from a breakdown of the insulating air layer between them, and also all through the cloud itself, and for a time a partial neutralization or electric equilibrium is effected. This continues until a further redistribution of charges is required and until again the breakdown potential is reached. The continued coalescence of charged water particles which were not discharged at the first breakdown, repeats the original condition, and so on. Unlike the case of a suspended charged metal body, a single discharge does not usually equalize the electric potential of cloud and earth. Instead, many successive discharges occur. It is probably fortunate for us that the process is as gradual as it is, for the ordinary partial discharges of the cloud are each terrific enough and tax our resources sufficiently when we seek to protect ourselves and our effects from them.

Various hypotheses have been proposed to account for the presence of electric charges in cloud masses, but there is no time to discuss them here, and there is in fact little that is really known as to the origin of the electricity of clouds. We shall briefly refer to the phenomena which characterize or accompany the electric discharges. The usual form which the discharge takes is that known as disruptive spark or fork lightning, a long flash or electric spark, joining earth and cloud, or cloud and cloud, and branching within the cloud mass like a tree. Oftentimes between cloud and earth there is seen the single streak zigzag in its course, but within the cloud it ramifies or branches extensively in several directions. In this way only can any considerable part of the cloud contribute its portion to the main discharge path, for, as stated before, the cloud can not act as a conducting body.

Some authorities treat lightning as a discharge of very high frequency like the ordinary discharge of a condenser or Leyden jar. In fact it has not been unusual to assume that such apparatus can be substituted and inferences drawn as to the nature and character of the lightning discharge from experimentation and tests with these laboratory appliances. There is, however, abundant reason to doubt that lightning discharges are really oscillatory. If they oscillate the conditions are such as to forbid such oscillation being of a high frequency order. The cloud discharge represents what is known as a discharge of a large capacity, and the length of the path or spark may reach thousands of feet or even many miles; a long inductive path, while the heat and light given out in every part of the path indicate a high resistance to the passage of the discharge. All of these conditions are together known to be inconsistent with the idea of high frequency oscillation. But the breakdown or discharge is extremely sudden and involves an almost instant rise of the current to a large value, so that the inductive effects upon surrounding structures, such as electric lines or circuits, are very energetic and sharp like a quick blow struck; and these lines or structures become the seat of rapid vibration or high frequency oscillations. The sudden blow of the hammer on a bell in like manner brings out all the rates of the vibration, fundamental and overtones, of which the bell is capable and in which the hammer itself takes no part.

The very sudden startling character of a lightning discharge leads to an exaggeration in the popular estimate of its more evident effects. The amount of light

given out is not so great as is often assumed. It does not give effects at all comparable with full sunshine. While doubtless the intrinsic brilliancy is very high the duration of the flash is small, generally only a minute fraction of a second. In photographs of lightning the landscape is generally seen only in outline or poorly lighted by the discharge. In the daytime, when the clouds are not dense enough to greatly darken the sky, the flash loses most of the blinding character it has when seen in the blackness of night. Similarly, the sound of thunder, though of terrifying quality, is not extraordinarily loud. It is a common experience when traveling in a train to note that the sound of even near-by flashes is smothered by the roar of the train so that no thunder is heard. The noise of thunder can not be due in any part, as is sometimes erroneously assumed, to collapse of the air upon itself and into a partial vacuum left by the spark. I have seen this error even recently repeated and even extended to include all the noise of thunder as due to such collapse. When, however, we consider that in a minute fraction of a second the air in the path of the discharge is so highly heated that, if it were confined, its pressure due to heat expansion alone would rise to more than ten atmospheres we can readily understand the explosive shock given to the surrounding air and the propagation therethrough of an intense air wave. In fact such waves from electric spark discharges and from dynamite explosions have been clearly recorded by photography. Moreover, that the collapse of the air after expansion can have little or no effect in the sound production, follows from the fact that the heated gas streak left in the path of the discharge takes an appreciable time to cool on account of its low radiating power. This is shown by the observation that a lightning discharge in dusty air is often succeeded by a luminosity of the streak which persists for a perceptible time and slowly fades away like the luminous trail of a meteor.

Another common misconception is that the prolonged rolling character of thunder is due to reverberations or echoes. In mountain regions with steep rock walls such reverberations possibly contribute to the effect, but it is now clearly recognized that a sufficient single explanation suffices for most cases. Owing to the great length of the lightning spark or path, we receive the sound from the nearer parts of the discharge far in advance of that from the more remote portions, and between these sounds are those from parts of the path at intermediate distances from the observer. It follows from this that no two observers at a distance from each other hear the same succession of sounds in the thunder of a discharge. Whenever portions of the discharge path are situated or extended in an approximate direction at right angles to the line from the observer, the sound from that part of the path is louder or of high amplitude owing to the sound from that part of the path reaching the observer's ear at the same instant. Whenever the path leads directly away from the observer the amplitude is less, the sound is less explosive and takes the character of an extended roll or rumble.

It will be seen from this that every twist and turn and every change of direction of the spark path with respect to the observer's position gives a varying loudness and sequence of sounds. Every branch of the main discharge in like manner records its position and direction, its twistings and bendings in these sound vibrations and sequences. It would seem possible even to record on a phonograph noises from sparks invisible to the eye and map the positions

of the sparks in space from records so produced. If this were done as it were stereoscopically or stereographically from two or more separated observing or recording places, the records would contain the necessary data for the reconstruction of the spark and its branches in space.

From the above considerations an attempt to determine the distance of a lightning stroke to earth by counting seconds elapsing between the flash and the first thunder and allowing five seconds to a mile approximately is seen to be futile. Should one of the cloud ramifications or branches of the great tree-like discharge extend in the cloud overhead with relation to the observer, and that part of the discharge be nearer to him than any other he will first hear a receding rumble above him, followed it may be by a heavy explosion from the main or approximately vertical spark between cloud and earth and from the parts of which his distance is nearly the same. This louder explosion will then be followed generally by a prolonged rumble of diminishing loudness which is the sound coming from the ramifications which lead farther to the distant parts of the cloud. Manifestly the counting of time should be between the flash and the heavy explosive sound due to the vertical part of the flash.

Bearing in mind that over the extent of cloud the charged water particles may be said to be waiting for a chance to discharge to earth, it is not surprising that any path which has been opened or broken down by disruption of the insulating layer of air should serve for the discharge of an extended body of cloud. The heated vapor or gas in the path of the discharge is a relatively good conductor of electricity serving to connect the cloud mass to the earth below. The significance of this is understood when it is known that many lightning discharges are multiple. Instead of a single discharge they consist of a number rapidly following one another through the path or spark streak opened to them by the first discharge. This first discharge opens the way or overcomes the insulating barrier to the discharge of portions of the cloud mass, which, on account of remoteness or lower potential, could not themselves have caused the breakdown. These repeated or multiple flashes are exceedingly dangerous, both to life and property. The first discharge may reduce wood to splinters and the subsequent ones set it on fire. The time interval between the successive discharges in such a multiple flash is quite variable and may be long enough to be easily perceptible by the eye. The multiple character is easily disclosed by the image in a revolving mirror. If a strong wind be blowing at the time of such a multiple flash, the hot gas conducting the discharges may be displaced laterally in the direction of the wind with the result of spreading out the discharges into a ribbon more or less broad. Photographs of these ribbon flashes show their true character plainly; each separate discharge appearing as a streak of light parallel to the others and at varying distances apart. In fact parallel discharges of exactly the same contour are sometimes observed many feet apart. Here the hot gas of the first discharge has evidently been shifted by the wind over a considerable space before the second and subsequent discharges took place. Heavy rain seems to weaken the air and help to precipitate a discharge. From the fact that strokes of lightning are often followed by increased fall of rain within a few seconds it is a prevalent idea that the increased downpour is caused by the discharge. In reality the reverse is the case, for just when a gush of rain has reached from the cloud down to within a

hundred feet or more from the ground, by far the major part of the air layer has been so weakened electrically by the presence of the water drops, that the discharge itself anticipates the completion of the distance of fall of the rain, and is therefore a short time in advance of the time when the descending gush of rain actually reaches the ground. As the gusts or gushes of rain are more or less local and sweep along with the storm cloud, they are apt to mark out the places of the most frequent lightning strokes. Shelter sought at such times under tall trees is particularly dangerous.

The amount of energy which may be concerned in a lightning discharge is neither definite nor capable of estimation. It would seem that the widest variations in energy may occur and this would account largely for the observed differences in the severity of the effects. It must be remembered also that by far the larger part is expended in the long spark in the air and cloud. Even when much damage is done to objects struck it is only a small fraction of the total energy which is expended on them. Most of the damage to property comes indirectly from the electric discharge by its energy being instantaneously converted into heat. This heat evolves steam and expanded gases in the interior of such materials as wood and causes explosion, shown in the splintering or rupture.

A curious effect, often noted when a tree is struck and shattered, is that when the splinters, sometimes of large size, are thrown bodily out to distances of many feet from the shattered tree, the splinters in their movement remain in parallel to the tree and in a vertical position. They are frequently found standing upright after a stroke and at distances ranging up to sixty or eighty feet away. This fact indicates that the projecting force is quite instantaneous and is exerted equally and at the same moment throughout the length of the splinter in a direction transverse to its length. Such splinters are sometimes ten or twelve feet in length and several inches thick. As will be seen, a person near a large tree which is so disrupted is in danger of being struck in a different way, even if he escapes being included in the path of the stroke itself. Aside from this mechanical danger it is known that to take refuge under a tall tree during a heavy thunderstorm is particularly hazardous. This is so because the human body is a better conductor than the tree trunk, particularly as the trunk itself is the last part to become thoroughly wetted by the rain. The leaves and upper parts are wet and more or less conducting while the tree trunk itself may be yet dry. In such a case the body of a person forms a good path or shunt to the dry trunk and is therefore particularly apt to be traversed by any stroke which reaches the tree.

As before indicated, damage to buildings and other such structures can in all cases be prevented by the provision of an effective shunting path to earth. A most essential feature of such a structure as the Franklin conductor is its good connection with the ground, or better its connection with what we know as a good ground. In early times it was considered that it was quite important that the tip or upper end of the conducting rod should be sharply pointed, or should bristle with sharp points, so to speak. The tips were gilded and the points made of gold or platinum to prevent rusting. The points were supposed to draw off the lightning silently from the cloud and so prevent strokes of lightning. But for millions of volts at cloud distances almost all irregular objects on the surface of the earth are practically pointed. Perhaps on this erroneous assumption of the action of points as applied here little stress

was laid on the direct path to earth being chosen and on the necessity of including with it or connecting to it other good paths such as gas pipes, bell wires and the like. There is no need of any special provision of points. A blunt end will do as well, for after all there is practically no silent drawing off of the charge from the cloud, for it is not an insulated conductor. The provision of a lightning conductor on a building undoubtedly increases its chances of being struck by lightning, but if properly arranged it also ensures that the structure shall suffer no harm therefrom. Viewed from our present standpoint it is a curious historical fact that in 1777, just after the war of the American revolution broke out, a miniature verbal war between the advocates of *blunts* and *points*, respectively, as applied to lightning conductors raged. In England party politics led many to condemn *points* as revolutionary and stick to *blunts*. The Royal Society by majority vote decided for points, but those who so voted were considered friends of the rebels in America. George III. took the side of *blunts*. Franklin, who from the first had prescribed points, wrote from France: "The King's changing his pointed conductors for blunt ones is a matter of small importance to me. For it is only since he thought himself safe from the thunders of Heaven that he dared to use his own thunder in destroying his own subjects." The king is reputed to have tried to get Sir John Pringle, then president of the Royal Society to work for blunts, but received the reply: "Sire, I can not reverse the laws and operations of nature." As stated above, it matters not at all which we may use. I have, indeed, seen a number of cases in which the sharp points of lightning conductors had been melted into rounded ends by lightning.

In the foregoing we have been considering the effects of such ordinary discharges of electricity as the disruptive spark, or zigzag flash. Apparently if the testimony is reliable there are other and more rare forms of discharge. I allude to sheet lightning, so-called globular lightning and to bead lightning. But it may be asked, why call sheet lightning a rare form? It is, indeed, true that when a storm is so far distant that the spark discharges can not be seen, as when it is below the horizon, or when the spark is blanketed by a mass of mist or cloud there is to be noted a diffused light or extended illumination, which, on account of distance, may not appear to be attended by thunder. This and similar effects are often called sheet lightning. From observations during a few heavy storms, however, I am led to infer the existence at rare intervals of a noiseless discharge between cloud and earth—a silent effect attended by a diffused light, and which may be the true sheet lightning. In my experience it has accompanied an unusually heavy downpour of rain, the whole atmosphere where the rain fell most heavily being apparently momentarily lighted up by a purple glow, seemingly close at hand in the space between the rain drops. The appearance has been seen in the daytime as an intense bluish or purplish momentary glow without any accompanying sound. It could scarcely have been illusory. It is hoped that other observers will carefully note any such like effect if it occurs. It is certainly a rare phenomenon.

It is quite common that any very bright flash, the details of which from its suddenness and intensity are unobservable, be alluded to as a ball of fire. Doubtless many of the reported cases of so-called ball or globular lightning may be explained as instances of this condition of things. Nevertheless, there are so many recorded instances, apparently in substantial agree-

ment, that it is difficult to escape the conclusion that there in reality exists this rare form of electric effect, globular lightning.

We can not properly discredit observations of phenomena which are so rare that our own chance for confirmation of them may never come. We must, in such cases, carefully scrutinize the testimony, examine the credibility of witnesses and their chances of being mistaken. It is certainly impossible at present to frame any adequate hypothesis to account for this curious and obscure electric appearance. The witnesses agree that it is an accompaniment of thunder-storms and that it resembles a ball of fire floating in the air or moving along a surface, such as the ground. It is not described as very bright or dazzling, and the size of the ball itself may be from an inch or two to a foot or more in diameter. Observers agree that it can persist for some time and that its slow movement allows it to be readily kept under observation while it lasts. When it disappears there is usually an explosion and a single explosive report like that of gun fire. Sometimes it is said to disappear silently. Usually the damage done by its explosion is only slight. This summary of characteristics is common to all accounts. Some accounts are even more detailed, mentioning that the fiery ball seemed to be agitated or with its surface in active motion. I have found two instances occurring many years apart and in widely different localities in which it is described as having a reddish nucleus, in diameter some considerable fraction of the whole. The outer fiery mass has been described as yellowish in color. In some instances it has been seen to fall out of a cloud. It is described as entering buildings and moving about therein. Personally I was for a long period in doubt as to the reality of this strange appearance, deeming it the result of some illusion, or a fanciful myth. But on hearing descriptions by eye witnesses known to me as persons not given to romancing, and finding their accounts to correspond closely with the best detailed descriptions in publications, my doubts have disappeared.

In one instance, while observing the lightning during a heavy thunderstorm, a companion, whose eyes were turned in a direction nearly opposite to my own, suddenly called to me that a ball had just dropped out of the cloud some distance away. The view of the ground was obstructed by buildings and I unfortunately just missed it. The noise of its explosion was, however, heard in the direction indicated by my fellow observer, as a single report like the firing of a gun. At the time I closely questioned him as to details of the appearance. Our ignorance of its possible nature is complete. No rational hypothesis exists to explain it. Science has in the past unraveled many obscure phenomena. The difficulty here is that it is too accidental and rare for consistent study, and we have not as yet any laboratory phenomena which resemble it closely.

Sometimes photographs taken during thunder-storms have been found to carry curiously contorted streaks in some degree resembling lightning flashes. Generally they have been found on plates upon which undoubted lightning discharges have been recorded. In some instances which have come to my notice the streaks have had the appearance of a string of dots or beads and have been taken to represent a very rare form of lightning known as bead lightning. A number of such photographs have been submitted to me for opinion as to the nature of the curious streaks. In all cases they are explained as due to the camera having been moved without capping the lens, permitting images of lights, such as arc lights, or spots of reflected

light from wet or polished surfaces to traverse the plate in an irregular course. They are then only records of the inadvertence of the lightning photographer. In one instance the effect was so curious that it was several years before the true explanation was found. In that case there were two wavy contorted streaks of perfectly parallel and of similar outline, but unequal in intensity, rising each from a rail of a single track railway, and apparently terminating in the air fifteen or twenty feet above the tracks. They were finally traced to a moving camera, and a reflection from the wet and polished rail surfaces of the light of an arc lamp located outside the field of view. It required a visit to the place itself to enable this conclusion to be reached. The particular beaded streaks or lines of dots were traced to the fact that the arc lamps causing them were operated by alternating currents which naturally give light interrupted at the zero of current; one hundred and twenty times per second being the usual rate. All this emphasizes the need of care and wholesome scrutiny or even skepticism before reaching a conclusion in such cases.

Is bead lightning, which has at times been described as observed visually, a reality? If it is it appears to be even rarer than the globular variety. Perhaps it is a string of globules; a variety of globular lightning. But we can not make assumptions. As in the case of globular lightning there is some testimony, which can not be wholly disregarded, tending to show that a form of discharge resembling a string of beads can actually exist. An account of an instance was given me within one hour after the occurrence itself. The witness was known to me as perfectly reliable. The appearance was described as a festoon of finely colored oval beads hung as it were from one part of cloud to another, and as persisting for some seconds while gradually fading away. The opposite ends of each bead were said to be different in color. It was seen during an afternoon thunderstorm and spoken of as very beautiful, and altogether different from the usual zigzag flash.

If I have dwelt upon these exceptional appearances at some length it is because they seem to show that in electricity there is much yet to learn and abundant opportunity for future investigation. It is certainly literally true that, in the language of Shakespeare, "There are more things in Heaven and earth, Horatio, than are dreamt of in your philosophy." Such work belongs to the science of physics, now recognized as fundamental in all study of nature's processes. In electrical engineering, which is in reality an art based upon applied physics, the subject of lightning protection has always been one of considerable if not vital importance. Just as a lightning discharge from a cloud clears up a path for other discharges to follow, so in electric undertakings it opens up paths for the escape of the electricity we are sending out to do the work intended, such as for lighting, power or other use. In the past, disablement of machinery in electric stations has not been rare. The recent growth of long-distance transmission involving hundreds of miles of wire carried on poles across country, over hills and through valleys, has set new problems of protection, and called for renewed activity in providing means for rendering the lines and apparatus immune to the baneful effects of electric storms. Judging the future by the past, we may conclude that, whatever difficulties of the kind arise, in the great future extensions of such engineering work, science and invention will provide resources ample for the needs, and the rapid advance will be continued unchecked.

ELIHU THOMSON

PRESIDENT TAFT'S MESSAGE

PARAGRAPHS of special interest to scientific men in President Taft's annual message to the congress concern the U. S. Naval Observatory and a Bureau of Health. They read as follows:

The generosity of Congress has provided in the present Naval Observatory the most magnificent and expensive astronomical establishment in the world. It is being used for certain naval purposes which might easily and adequately be subserved by a small division connected with the Navy Department at only a fraction of the cost of the present Naval Observatory. The official Board of Visitors established by Congress and appointed in 1901 expressed its conclusion that the official head of the observatory should be an eminent astronomer appointed by the President by and with the advice and consent of the Senate, holding his place by a tenure at least as permanent as that of the superintendent of the Coast Survey or the head of the Geological Survey, and not merely by a detail of two or three years' duration. I fully concur in this judgment and urge a provision by law for the appointment of such a director. It may not be necessary to take the observatory out of the Navy Department and put it into another department in which opportunity for scientific research afforded by the observatory would seem to be more appropriate, though I believe such a transfer in the long run is the best policy. I am sure, however, I express the desire of the astronomers and those learned in the kindred sciences when I urge upon Congress that the Naval Observatory be now dedicated to science under control of a man of science who can, if need be, render all the service to the Navy Department which this observatory now renders, and still furnish to the world the discoveries in astronomy that a great astronomer using such a plant would be likely to make.

* * * * *

For a very considerable period a movement has been gathering strength, especially among the members of the medical profession, in favor of a concentration of the instruments of the national government which have to do with the promotion of public health. In the nature of things, the medical department of the army and the medical department of the navy must be kept separate. But there seems to be no reason why all the other bureaus and offices in the general government which have to do with the public health or subjects akin thereto should not be united in a bureau to be called the Bureau of Public Health. This would necessitate the transfer of the Marine Hospital Service to such a bureau. I am aware that there is a wide field in respect to the public health committed to the states in which the federal government can not exercise jurisdiction, but we have seen in the Agricultural Department the expansion into widest usefulness of a department giving attention to agriculture when that subject is plainly one over which the states properly exercise direct jurisdiction. The opportunities offered for useful research and the spread of useful information in regard to the cultivation of the soil and the breeding of stock and the solution of many of the intricate problems in progressive agriculture have demonstrated the wisdom of establishing that department. Similar reasons, of equal force, can be given for the establishment of a Bureau of Health that shall not only exercise the police jurisdiction of the federal government respecting quarantine, but which shall also afford an opportunity for investigation and research by competent experts into questions of health affecting the whole country, or important sections thereof, questions which, in the absence of federal governmental work, are not likely to be promptly solved.

THE GEORGE CROCKER SPECIAL RESEARCH FUND

BY the will of the late George Crocker, of New York City, valuable property, said to be worth about $1,500,000, has been bequeathed to Columbia University for researches on the cause, prevention and cure of cancer. The clause in the will relating to this bequest is as follows:

I order and direct my executors hereinafter named to sell my land, corner of Sixty-fourth Street and Fifth Avenue, in the Borough of Manhattan, City of New York, together with the house thereon, known as No. 1 East Sixty-fourth Street, and the contents thereof, as well as all my real estate at Darlington, in the County of Bergen, State of New Jersey, together with the houses thereon and the contents thereof, and the horses, cattle and other personal property connected therewith, and to convert the same into money and pay the net proceeds thereof to the trustees of Columbia College in the City of New York, to be held by such trustees and invested as a permanent fund, to be known as the "George Crocker Special Research Fund," the income of which shall be applied in such manner as said trustees may

from time to time determine in the prosecution of researches as to the cause, prevention and cure of cancer, and, should the progress of science at any time make the prosecution of further research in regard to cancer unnecessary, then the income of said fund may be used as said trustees may from time to time determine in the prosecution of other researches in medicine and surgery, and in the science allied thereto, with a view of preventing and curing diseases and of alleviating human suffering.

Provided, however, that no part of the principal or income of this fund shall be at any time used for the erection of a building.

CHANGES AT HARVARD COLLEGE

At a meeting of the Board of Overseers of Harvard College, held in Boston, December 8, 1909, the president of the university communicated the following votes of the faculty of arts and sciences modifying the choice of electives:

1. That a standing committee of nine, of which the president shall be chairman, be appointed from the faculty, with power to associate with itself a large number of advisers for students.
2. That the committee prepare general rules for the choice of electives, to be approved by the faculty, based upon the principle that a student must take a considerable amount of work in some one field, and that the rest of his courses must be well distributed.
3. That at the end of his first year in college each student be required to present to his adviser a plan of study for the remainder of his college course; and that the plan must conform to the general principles laid down by the committee, unless the committee is satisfied that the student is earnest and has sufficient grounds for departing from those principles.
4. That a student's plan be subsequently changed only for a cause satisfactory to the committee.

And after debate thereon, the board unanimously approved said votes, and authorized the carrying out of the same.

The president of the university communicated orally to the board the contemplated establishment by the corporation of a freshman dormitory, and explained the purpose and scope of the same, and after debate thereon, the board unanimously voted to approve the establishment of the said dormitory as contemplated by the corporation.

EDUCATION AT THE BOSTON MEETING OF THE AMERICAN ASSOCIATION

Members of the American Association who are interested in education as well as in science will find much in the program of the Boston meeting to attract them. Because of the establishment of the section of education a number of educational interests are grouping themselves around the American Association, and this manifests itself in the program of the coming meeting by the fact that there are educational meetings scheduled for nearly every morning and afternoon of the session.

Section L itself will hold three sessions. The first of these on Tuesday afternoon will be devoted to the discussion of scientific problems in general education by members of the section. On Wednesday afternoon reports will be made by the General Education Board, the Carnegie Foundation for the Advancement of Teaching and the Bureau of Education on their studies of the American college. At 4.30 on that day, Professor Dewey, the retiring vice-president, will deliver his address on "Science as a Method of Thinking and as Information in Education." On Thursday morning the committee on the Distribution of Students in Elective Courses will present its report.

The section will hold also two joint meetings; one on Tuesday morning, with the American Federation of the Teachers of the Mathematical and Natural Sciences, to which preliminary reports from several of the section committees of the International Commission on Teaching Mathematics will be presented and other topics of general interest to science teachers discussed. The other will be held on Wednesday morning with the Social Education Club of Boston and will be devoted to the discussion of the problem of social education.

Besides these meetings, a number of others have been arranged by the local associations of teachers and by other sections of the association. Section A will listen to a prelim-

inary report from the International Commission on the Teaching of Mathematics; and Section B plans to devote one session to a discussion of the teaching of physics. The Social Education Club, of Boston, plans to hold one evening meeting with a program that should be of particular interest. The Eastern Association of Physics Teachers, the Association of Mathematical Teachers in New England and the Association of Physics Teachers of Washington expect to hold meetings and render programs that will be valuable to those interested in educational matters.

The American Federation of Teachers of the Mathematical and Natural Sciences will hold its annual business meeting on Monday afternoon. The American Nature Study Society will meet on Saturday morning to discuss the problem of physical nature study. All of these meetings are open to the public.

THE AMERICAN PHYSIOLOGICAL SOCIETY

The preliminary program of the twenty-second annual meeting to be held at the Harvard Medical School, Boston, December 28–30, is as follows:

Tuesday, December 28

9:00 A.M.—Reading of papers, followed by a business session after 12 o'clock.

2:30 P.M.—Meeting of Section K—Physiology and Experimental Medicine—American Association for the Advancement of Science. (Lecture Room, Building, of Harvard Medical School).

Address of the retiring vice-president, W. H. Howell.

Discussion of the Ductless Glands.

R. H. Chittenden, General Chemical Aspect of Internal Secretion.

S. P. Beebe, Thyroid.

J. V. Cooke, Parathyroid.

Harvey Cushing, Hypophysis.

W. G. MacCallum, Pancreas.

Swale Vincent, Suprarenal.

8:30 P.M.—Joint smoker with the Association of American Anatomists and the American Society of Biological Chemists at the Hotel Westminster, Copley Square.

Wednesday, December 29

9:00 A.M.—Joint session of the American Society of Biological Chemists and the American Physiological Society.

2:00 P.M.—Visit to the Carnegie Nutrition Laboratory (by invitation of Dr. F. G. Benedict).

3:00 P.M.—Physiological demonstrations (Harvard Physiological Laboratories).

Thursday, December 30

9:00 A.M.—Reading of papers, followed by a business session after 12 o'clock.

2:00 P.M.—Demonstrations.

THE AMERICAN SOCIETY OF NATURALISTS

The American Society of Naturalists will meet at the Harvard Medical School, Boston, Mass., on Wednesday, December 29, 1909.

The program will consist of original papers and demonstrations of studies on evolution. The following papers are promised and a few others will probably be added to the list:

E. M. East: "A Mendelian Interpretation of Variation that is apparently Continuous."

J. B. Watson: "The Problem of Determining Color Vision in Animals."

W. L. Tower: Title not yet received.

G. H. Shull: "The Inheritance of Sex in *Lychnis alba*."

Frank E. Lutz: "Experiments concerning the Reversion of Domesticated Races to the Wild Type."

W. J. Spillman: "Mendelian Phenomena Independent of de Vriesian Hypotheses."

J. Reighard: "Biological Meaning of Conspicuousness in Animals."

T. H. Montgomery: "Sexual Selection in Spiders."

D. H. MacDougal: "Origination of Parasitism in the Higher Plants."

Anne M. Lutz: "The Relation of Chromosome Number to Vegetative Characters in the *Œnothera*."

H. S. Jennings: "Experimental Evidence on the Effectiveness of Selection."

C. H. Eigenmann: "The Divergence and Convergence in Characins."

Ulric Dahlgren: "Origin of the Electric Tissues in Teleost Fishes."

W. E. Castle: "On the Nature of Mendelian Factors."

R. R. Gates: "The Material Basis of Mendelian Phenomena."

E. Brainard: "The Evolution of New Forms in *Viola* through Hybridism."

A. F. Shull: "The Artificial Production of the

Parthenogenetic and Sexual Phases in the Life Cycle of *Hydatina senta*."

Franz Boas: "The Influence of Heredity and of the Environment on Man."

C. W. Beebe: "Racket Formation in the Tail Feathers of the Mot-mot."

Most of the papers will be illustrated by actual specimens or other demonstrations and time will be allowed for discussion. The society will probably meet in two sessions, morning and afternoon.

The Naturalists' dinner will be held on the evening of Wednesday, December 29, when the address of the president, Professor T. H. Morgan, will be delivered on "Chance or Purpose in the Evolution of Adaptations."

As previously, members of the special societies devoted to biological sciences are invited to attend the dinner of the naturalists.

Those expecting to attend the dinner will greatly oblige the committee in charge, if they will notify Dr. R. P. Bigelow, Massachusetts Institute of Technology, Boston, Mass., at the earliest opportunity.

H. McE. KNOWER,
Secretary

SCIENTIFIC NOTES AND NEWS

THE Nobel prizes for the present year have been awarded as follows:

For Physics—Divided between Mr. Guglielmo Marconi and Professor Ferdinand Braun, of Strassburg.

For Chemistry—Professor Wilhelm Ostwald, of Leipzig.

For Physiology or Medicine—Professor Theodor Kocher, of Berne.

For Literature—Selma Langerlof, the Swedish authoress.

For the Promotion of Peace—Baron D'Estournelles de Constant, president of the French parliamentary group for international arbitration, and M. Beernaert, former Minister of State of Belgium.

THE address of the retiring president of the American Association for the Advancement of Science, Professor T. C. Chamberlin, of the University of Chicago, will be given in Sanders Theater, Harvard University, on Monday evening, December 27, and will be followed by a reception in Memorial Hall.

DR. MAX VERWORN, professor of physiology in the University of Göttingen, will be the next Silliman lecturer at Yale University.

THE medical faculty of the University of Budapest has offered the chair of experimental biology to Professor Jacques Loeb, of the University of California. Professor Loeb lectured before the International Medical Congress at Budapest last September and delivered a course of lectures at the University of Budapest in June.

MR. FRANCIS DARWIN, F.R.S., has been made doctor of the University of Brussels and a corresponding member of the Institut National of Geneva.

A COMMITTEE has been formed at Cambridge to present a portrait to Mr. A. E. Shipley, F.R.S., lecturer in natural science at Christ's College and university reader in zoology.

THE American Institute of Electrical Engineers has appointed Professor A. E. Kennelly, of Harvard University, president of the United States national committee of the international electrotechnical commission.

THE Royal Meteorological Society has awarded the Symons gold medal to Dr. W. N. Shaw, F.R.S., in recognition of his work for meteorology.

SINCE the return of the DeMilhau Peabody Museum South American Expedition, Dr. William C. Farabee has received from the *Universidad Mayor de San Marcos de Lima* a diploma as honorary member of the faculty of sciences in the university, for "scientific merits and important services rendered to the government of Peru." Besides the formal communication from the university, a personal letter from the president of the republic accompanied the diploma.

MAJOR CHARLES E. WOODRUFF, of the medical corps of the U. S. A., has been detailed as the medical officer in charge on the Island of Corregidor, at the mouth of Manila Bay, where extensive fortification construction is being done.

DR. WALTER LEHMAN, of the Royal Ethnographical Museum, of Berlin, has returned from an expedition to Central America and

Mexico and is at present working in the museums of this country.

AT the meeting of the American Philosophical Society on December 17, the annual address of the president will be given by Dr. William W. Keen, and a historical paper will be presented by Dr. Eduard Meyer, professor of ancient history in the University of Berlin.

THE annual public address under the auspices of the Entomological Society of America will be given this year, on the evening of Thursday, December 30, by Dr. John B. Smith. The title is "Insects and Entomologists: their Relation to the Community at Large." Members of the American Association and of the affiliated societies and the public in general are cordially invited to attend.

DR. L. A. BAUER gave an illustrated address at the annual meeting of the Washington Society of Engineers on December 7, on "The Non-magnetic Yacht *Carnegie* and her Producer Gas Engine."

ON Friday, December 3, Professor J. A. Holmes, of the U. S. Geological Survey, lectured before the students of the College of the City of New York on "Explosions in Coal Mines."

THE Huxley lecture at Birmingham University was delivered on December 1 by Professor W. Bateson, F.R.S., his subject being "Mendelian Heredity."

WE learn from *Nature* that the meeting of the Royal Irish Academy on November 30 was occupied by a commemoration of Charles Darwin, the date nearly coinciding with that of the publication of "The Origin of Species" fifty years before. The president, Dr. F. Tarleton, opened the proceedings, and the following short addresses were given on the influence of Darwin's work: Geology, Professor G. A. J. Cole; geographical distribution of animals and plants, Dr. R. F. Scharff; zoology, Professor G. H. Carpenter; botany, Professor T. Johnson; anthropology, Professor A. F. Dixon.

THE collection of lichens formed by the late Clara E. Cummings, Hunnewell professor of cryptogamic botany at Wellesley College, has been bought by the college and will be installed in the department of botany as a memorial to Professor Cummings.

BY subscription a fund has been created in honor of Dr. Christian Fenger, of Chicago, who died in 1902. The fund is to be known as the Fenger Memorial Fund and the income is to be used to promote medical investigation. The directors of the Fenger Memorial Association have set aside $400 for this purpose for 1910. Applications with the necessary details should reach the secretary, Dr. L. Hektoen, 1743 W. Harrison Street, Chicago, not later than February 1, 1910.

A SCHOLARSHIP in engineering at the University of Pennsylvania has been founded by Mrs. S. W. Carlton, Jr., in memory of her father, the late Dr. Coleman Sellers, the eminent engineer.

DR. JEAN BINOT, head of the department of pathological anatomy of the Pasteur Institute, Paris, died at the end of November.

THE new administration building of the Carnegie Institution of Washington, situated at Sixteenth and P Streets, will be open to the public for inspection on Wednesday, Thursday and Friday, December 15, 16 and 17, from 2 to 5.30 P.M. Opportunity will also be offered to view an exhibit of the work of the institution and its departments.

SECTION B, of the American Association and the American Physical Society, will meet on Tuesday, December 28, in the Lowell (new) Lecture Hall, Cambridge, where the vice-presidential address will also be given on Tuesday afternoon. The Wednesday, Thursday and Friday sessions of Section B and the American Physical Society will be held at the Institute of Technology, as previously announced. Dr. L. A. Bauer, chairman of the section, has addressed to physicists the following letter:

It gives me much pleasure to announce that, judging from present indications, our coming meeting at Boston will be a success. Titles of papers have already been received from eminent physicists, among them Michelson and Runge, of Göttingen.

For one reason or another some of our foremost

investigators have not always attended the American Association for the Advancement of Science meetings and have, in fact, been known to speak disparagingly of them. However, it should be remembered that it lies within our own power to make the meetings just what we want them to be. I, for one, believe that we have sufficient talent on this continent to make our gatherings as successful as the recent one of the British Association for the Advancement of Science at Winnipeg.

If you have an important contribution to make let me urge you to forward immediately the title and abstract to one of the secretaries and above all to lend encouragement by your presence. It is hoped that our meeting will be truly one of "general consultation, a focal point for condensed opinions, for authoritative statements, for criticism from varied standpoints," as also of friendly intercourse among sympathetic workers.

If you are not already a member of the American Association for the Advancement of Science it behooves you to become so at the earliest possible date.

"I hold every man a debtor to his profession; from the which as men of course do seek to receive countenance and profit, so ought they of duty to endeavor themselves by way of amends to be a help and ornament thereunto."—*Francis Bacon.*

THE department of plant pathology of the New York State College of Agriculture, at Cornell University, announces the establishment of a second temporary industrial fellowship. This fellowship, which is known as the C. W. Stuart & Company Fellowship has been established by C. W. Stuart & Company, nurserymen, of Newark, N. Y. The purpose of this fellowship is the investigation of the diseases of nursery stock with particular reference to the fire blight or pear blight disease. This fellowship carries an annual salary of $500 per year and $250 per year for carrying on the work and is to continue for two years. Mr. V. B. Stewart, A.B. (Wabash, '09), has been appointed fellow. He spent the summer of 1909 in one of the nurseries of this company.

MR. ZACCHEUS DANIEL, Thaw fellow in astronomy at Princeton University, discovered a new comet on December 6, while working in the Prospect Avenue Observatory. It is of about the ninth magnitude, the nucleus being of about the thirteenth magnitude. The position was Dec. 7.8759 Greenwich meantime, R. A. $6^h 16^m 44^s.0$, Dec. $+34° 55' 15''$.

THE Astronomical and Astrophysical Society of America through its Comet Committee is soliciting cooperation in the observation of Halley's comet at its approaching return, and has prepared a circular letter of advice with regard to such observations that has been widely distributed among observatories. A copy of this circular will be mailed to any astronomer who may desire to use it, upon request being made to the chairman of the committee, Professor G. C. Comstock, Washburn Observatory, Madison, Wisconsin. Among the matters treated in the circular are: Photographing Comets by Professor Barnard, Spectroscopic Observations by Professor Frost, Photometric Observations by Professor E. C. Pickering, etc. It is the purpose of the Comet Committee to collate as far as possible the photographic results obtained and for that purpose it would be pleased to receive copies (positives on glass) of photographs of the comet from all parts of the world. This wide distribution of photographic observations is regarded as a matter of prime importance and in order to obtain them where they would otherwise be lacking, in the broad expanse covered by the Pacific Ocean, the committee, aided by a grant from the National Academy of Science, at Washington, is preparing to send out to the Hawaiian Islands an expedition that will have as its sole purpose the photographing of the comet during the months of its greatest brilliancy, March to June, 1910.

THE following scientific papers have been given during the months of October and November at the meetings of the University of Colorado Scientific Society: "The Darwin Celebration, Cambridge," Professor T. D. A. Cockerell; "Comets; with special reference to Halley's Comet and its approaching return," Professor Oliver C. Lester; "Forests and Stream Flow," Professor Clement C. Williams; "Rabies," Dr. A. R. Peebles; "The Conservation of Human Life—More important than that of Forests, Waters, Soil or Minerals," Professor Francis Ramaley.

The annual joint meeting of the Iowa Society of the Archeological Institute of America, the Iowa Anthropological Society and the Iowa branch of the American Folk-Lore Society, was held at the State University of Iowa, November 26 and 27. At the opening session on Friday afternoon, a greeting was extended to the visitors by President George E. MacLean, of the university, which was responded to by State Librarian Johnson Brigham, of Des Moines. Papers on many subjects of interest were presented, among them a report on the Boone Mounds in Iowa by Curator Harlan, of the state historical department; a discussion of the human population of the Hawaiian Islands by Professor Charles C. Nutting, of the State University of Iowa, and a lecture by Mrs. A. M. Mosher, of Cambridge, Mass., entitled "The Story of the Isle of Man." Officers of the societies elected for the coming year are the following:

Iowa Society of the Archeological Institute:

President—E. K. Putnam, of Davenport, Iowa.

Secretary-Treasurer—Professor Charles H. Weller, of the State University of Iowa.

Iowa Anthropological Society:

President—E. K. Putnam, of Davenport, Iowa.

Secretary—J. H. Paarmann, of Davenport, Iowa.

Iowa Branch of the American Folk-lore Society:

President—Charles B. Wilson, of the State University of Iowa.

Secretary—E. K. Putnam, of Davenport, Iowa.

The regular monthly meeting of the Oregon State Academy of Sciences was held on October 16, the speakers being Dr. David Walker and Dr. L. J. Wolf, on "Arctic Explorations." Dr. Walker had been on two expeditions, the first with McClintock, and Dr. Wolf has been with Peary in 1905–6. Dr. Walker gave an account of early explorations and Dr. Wolf of his own experiences.

The United States Commissioner of Education, Dr. E. E. Brown, has announced that at the request of the Belgian government he has appointed an American committee to have charge of American interests at the third International Congress of Home Education to be held in Brussels in 1910. The membership of the American committee is Professor M. V. O'Shea, the University of Wisconsin, chairman; Professor W. C. Bagley, the University of Illinois, secretary; President Wm. L. Bryan, the University of Indiana; Mr. Wm. H. Allen, expert for the Sage Foundation, New York; Professor Irving Fisher, Yale University, chairman of the Committee of One Hundred; Judge Ben B. Lindsey, Denver; Superintendent Frank B. Cooper, Seattle; Mary E. Ahern, editor Public Libraries, Chicago; President E. R. Johnstone, New Jersey; President Lewis H. Jones, State Normal College, Michigan; Charlotte Perkins Gilman, editor, New York; Mrs. H. K. Schoff, president of the National Congress of Mothers, Philadelphia; Dean W. S. Sutton, University of Texas; Professor Henry Suzzalo, Columbia University; Bertha Payne Miller, the University of Chicago.

The International Congress of Mining, Metallurgy, Applied Mechanics and Practical Geology, held at Liége in 1905, resolved to accept the invitation of the Rhenish-Westphalian Mining Industry to hold the next congress in Rhenish-Westphalia, and it is now announced that the congress will be convened at Düsseldorf, the last week in June, 1910. It will be divided into the following sections: (1) Mining, (2) Metallurgy, (3) Applied Mechanics, (4) Practical Geology.

One of the most widely known of the rarer metals is tungsten. The production of this metal in the United States, however, is not large, as a little of it goes a long way for some of its most important uses. As by far the largest part of the tungsten produced is used in making tool steel, the demand for tungsten decreased greatly during the recent depression in the steel industry. In 1908 the domestic production of tungsten ore, reduced to an equivalent of ore carrying 60 per cent. of tungstic trioxide (WO_3), the ordinary commercial basis in the United States, was 671 short tons, valued at $229,955, as against 1,640 tons, valued at $890,048, in 1907. The statistics at present available from foreign countries show a similar decline. These figures are taken from a report by F. L. Hess, of the United States Geological Survey, published in an advance chapter from "Mineral

resources of the United States, calendar year 1908." Mr. Hess gives also details of the industry by states, notes on the occurrence and uses of tungsten, and a partial bibliography. Tungsten is of wide occurrence, but the individual deposits can hardly be said to be large. As a rule they are "pockety"—that is, they occur in lenticular masses or small shoots. Many of those at the surface are quickly and easily mined, but it may then take all the profits derived from the first ore body to locate another one. The tungsten minerals used as ores are hübnerite, a tungstate of manganese; wolframite, a tungstate of manganese and iron; ferberite, a tungstate of iron; and scheelite, a tungsten of calcium. They generally occur in veins cutting igneous rocks that contain much silica, such as granite and granodiorite. Some simple tests for identifying these minerals are described by Mr. Hess. The most important use of tungsten is as an alloy for tool steel, to which it imparts the property of holding temper at a much higher temperature than high-carbon steels. When lathe tools are made of tungsten steel the lathe may be speeded up until the chips leaving the tool are so hot that they turn blue. It is said that about five times as much work can be done by a lathe built for such speeds and work and fitted with tungsten-steel tools as can be done by the same lathe with carbon-steel tools. From 16 to 20 per cent. of tungsten is ordinarily used in lathe tools.

THE *Journal* of the American Medical Association states that the production of radium has been carried on in Johannistal to such a degree that at present there is available a quantity equivalent to 1 gm. (15 grains) of the pure substance. Several tons of the ore had to be worked up before an appreciable amount was obtained. It is intended now to put the available quantity on the market solely for scientific purposes and for charitable institutions. It will be sold in quantities of 1 mg. (about $1/60$ grain) of the 5 per cent. and the 10 per cent. salt. Bromid of radium has been chosen. The price of the 5 per cent. salt will be 1,080 crowns ($244) per portion ($1/60$ grain). The sale will take place in the radium institute just now in course of erection. A gift by an anonymous benefactor, who gave $100,000 for this purpose on the understanding that an equal sum should be provided by the state, enabled the Vienna University to obtain its radium research institute, the first in the world as regards equipment for investigators. The necessary appropriation having been voted, the building is now almost ready for use.

UNIVERSITY AND EDUCATIONAL NEWS

THE Chicago *Record-Herald* says: "Plans are in contemplation for giving the University of Chicago the finest physical laboratory in the United States, if not in the world. It is said that before all the plans are consummated the plant will have cost $1,000,000. All of the money is to be furnished by Martin Ryerson, president of the board of trustees of the university, who also was the donor of the present Ryerson laboratory at the university."

MR. SAMUEL MATHER, of Cleveland, and his children, have offered to erect for the College for Women of Western Reserve University, a building for class and lecture rooms, in memory of Mrs. Florence Stone Mather.

THE contract for the new chemistry building of Rutgers College has been awarded. The building will be located about 100 feet north of the engineering building which was completed last year. It will be built of brick with terra cotta trim and will conform architecturally to the engineering building. On the first floor will be a large lecture room seating about 200, and three class rooms, two seating about 50 students and one for 30 students. On the second floor will be the qualitative laboratory for 96 students, the quantitative laboratory for 64 students, a laboratory for work in electrochemistry and one for water analysis, professors' private offices and laboratories and a supply room. In the basement is the laboratory for the elementary work of freshman year which will accommodate 162 men, a laboratory for organic chemistry accommodating 24 men and the necessary heating and ventilating apparatus and a stock room.

THE annual meeting of the Association of American Universities will be held at the University of Wisconsin, January 4 and 5.

The University of St. Andrews will celebrate its five hundredth anniversary in September, 1911.

An exchange of professorships and students between universities and academies among all the American republics has been proposed by Secretary Knox. The suggestion has commended itself to the governing board of the International Bureau of American Republics, which has recommended that the proposed interchange shall figure in the program of the fourth Pan-American Congress to be held at Buenos Ayres next summer.

Mr. Walter George Smith, a Philadelphia lawyer, has resigned as a trustee of the University of Pennsylvania owing to the election of Dr. L. P. Lichtenberger as associate professor. He objected to Dr. Lichtenberger's views on divorce expressed by him at a meeting of the American Sociological Society in Atlantic City last year.

A new department of economic entomology has been organized in the College of Agriculture of the University of Wisconsin, and Mr. J. G. Sanders, of the U. S. Bureau of Entomology, has been appointed assistant professor in charge.

Professor H. G. Bell, of the Iowa State College, has been appointed professor of agronomy at the University of Maine.

Mr. Donald F. MacDonald, junior geologist, U. S. Geological Survey, is this winter in charge of the work in geology at Tulane University, New Orleans.

DISCUSSION AND CORRESPONDENCE

NATIONAL LEADERSHIP IN EDUCATION

The recent communications to Science of Mr. E. C. Moore and Mr. Theo. B. Comstock open a field that can not fail to be of interest to specialists in education, and of great importance to the country generally.

It is a good suggestion that the significance of the nation's work in education would be more adequately indicated by having a secretary of education than it ever could be by the office of commissioner of a bureau. If it should become a question of room in the President's cabinet, it might be entirely feasible to combine the functions of the Departments of War and Navy, or gradually to do away with them altogether. This would be especially appropriate, and in the line of just recognition, since no factor in our national life bids fair to do more to render these departments useless than education itself.

In our system of state independence as opposed to national unity, it is very difficult to say what could be done were the nation to assume definite control of general education. The already established departments of the executive branch of the national government vary in the degree of control of the field assigned to them. The existence of absolute control of the Postmaster General and the divided control of the Attorney General may be explained on the basis of the fact that one has organized a system for every one's convenience at small cost, while the other may threaten to encroach on certain "inalienable rights." The degree of control in either and all cases would also vary with the confidence inspired by the acts of the department. The mind of the nation shows signs of moving strongly to those factors in its life which are obviously affecting the general welfare. Here would lie the great hope of a Department of Education.

There are certain phases of the possible work of a Department of Education that seem to the writer to be of paramount importance. The west, the east, the north and the south have developed antagonisms through isolation and through variety of locality interests. In all these regions magnificent work in constructive ideas in the field of education is being done in spots. But except for the evanescent results of educational conferences and the poorly circulated printed page, there is nothing to help a great idea to stick. If in the state of New York an educational leader formulates the idea that the schools and colleges should train their students to be intellectually honest, there should be some central authority to recognize the far-reaching application that idea might have in curing us of the habit of indirection in official and business dealings, and in removing sectional prejudice.

If an able essay is written in the state of California showing that morality is a social obligation, there should be some means of bringing that idea to the notice of all the people. How could these things be done? For answer we may ask, how does the Department of Agriculture utilize the ideas of scientific men? If we establish experiment stations to discover means of conserving our material resources, why should we not establish experimental schools to test the usefulness of ideas directed toward the problem of social betterment?

Experimental schools under the supervision of a Department of Education would certainly be more productive of good from the very first than the occasional model school here and there through the country, for at least these three reasons: because the literature of all previous experiments in all countries would be at their immediate command, because the ideas of a nation's teachers would flow to it naturally, and because the successes and, equally important, the failures could always be matters of public knowledge.

We need better and more productive methods of school administration than those commonly employed. To this end national experimental schools could "try out" the various ideas along democratic lines that have come in our effort to free ourselves from the autocratic domination of one or a few strong or unprincipled men in control of systems of schools. Moreover, the classical, the scientific and the "practical" subjects must be analyzed as to the character of subject-matter, and experimented with for results. We have the dictum of the middle ages that the classical languages bring culture to the mind of the learner. Are there not other subjects which may yield the product of culture? Again, teachers of the natural sciences have long claimed a monopoly of material which on being studied trains students to think. We who are in the work must soon acknowledge that we have not proved our case. The explanation of failure may lie in the possibility of our not knowing how to handle our material. There can be no question that the natural sciences do present the opportunity for training to thinking. National experimental schools could take up the discoveries in methods made by isolated teachers of science, and make them productive of good to great numbers of the younger generation of citizens. The help to a nation of generally non-thinking people might be enormous.

National experimental schools covering all the work from kindergarten to college should be established in various parts of the country, for the benefit of the local schools and to the profit of the national schools themselves. For administrative as well as for pedagogical and social reasons, these schools should offer, for example in the secondary grade, *all* the subjects now taught in the classical or special high schools. Only through the organization of this, a cosmopolitan high school, could comparative results be obtained.

In this connection we should not fail to consider the expense of possibly a score of national schools. For that we could draw on the credit of the future to the extent of the cost of a few "dreadnoughts."

Henry R. Linville

Jamaica, N. Y.

THE ASSOCIATION OF AMERICAN CHEMICAL RESEARCH LABORATORIES

To the Editor of Science: Permit me, Sir, to correct an error in my letter printed in Science, issue of November 5, 1909. Among the laboratories which had, at the Clark University celebration meeting on September 16, joined the newly formed Association of American Chemical Research Laboratories, my letter mentioned that of Harvard University. This is due to a misunderstanding. Professor Richards, the chairman of the department, while "believing most heartily in the spirit and idea" of the association, had not explicitly pledged the Harvard laboratory to join it, and now the director of the laboratory, Professor Sanger, who has charge of all business matters, has definitely decided against adding the laboratory to the association list, in the belief that this would be contrary to "the terms under which our chemicals and apparatus are imported duty free."

I have thought it scarcely necessary to point out that the borrowing of supplies by educa-

tional institutions from one another is by no means an innovation, and its legality seems out of serious question. At any rate, the function of the new association is merely, through its secretary, to *inform* members as to where they can *borrow* (if they like) urgently needed research chemicals while waiting for them to arrive from Germany. I have received a number of letters prophesying usefulness for the undertaking.

M. A. ROSANOFF,
Secretary

CLARK UNIVERSITY,
WORCESTER, MASS.,
November 20, 1909

THE CIVILIZATION OF BOHEMIA

TO THE EDITOR OF SCIENCE: In the first paragraph of the address by Dr. M. Toch, on the first page of SCIENCE, of November 19, there occurs a certain generalization on the effects of illiteracy in several European countries. The writer says: "In many of the countries of Europe illiteracy is universal"—which, of course, is not correct itself. And this is followed further on, as in illustration of the effects of the illiteracy, by the sentence: "What have those countries like Roumania, Bulgaria, *Bohemia* (italics my own), Hungary, Russia and dozens of others, ever amounted to, and what are their commercial relations with the rest of the world, compared with Germany, France, England or the United States?" Now all I desire is to say a word regarding Bohemia, which is the land of my birth. The inclusion of that country in the above sentence is extremely unjustifiable, for as any statistics on that question, including the data of the U. S. Bureau of Immigration, will show, Bohemia leads all the countries of Europe, including the greater part of Germany, in the lowness of the percentage of the illiterate, these being practically reduced to the defectives. And as to whether that country ever amounted or now amounts to anything in the sciences, arts, industries, etc., it is sufficient to refer to history and to the commercial and tax statistics of the Austrian empire. In view of these facts the above statement must be characterized as a very loose one and it is regrettable that it found place in this esteemed journal.

ALEŠ HRDLIČKA

WASHINGTON, D. C.,
November 19, 1909

MARS AS THE ABODE OF LIFE

TO THE EDITOR OF SCIENCE: On page 339 of SCIENCE I notice "2" has been printed for "r" in the denominator of the right side of the formula in the middle of the page. It reads correctly in my copy of the proof. The thing is evident as a misprint to any mathematician from the deductions—but it may as well be stated.

PERCIVAL LOWELL

QUOTATIONS

THE U. S. NAVAL OBSERVATORY

THE President's recommendation concerning the Naval Observatory is eminently sound. He urges that the official head of that great astronomical establishment should be an eminent astronomer, and not a naval officer detailed for service for a shorter or longer term. This mode of filling the post of head of the observatory could not have survived so long as it has were it not for the entirely false notion conveyed in the name of the institution. As the President truly says, all the uses of the observatory specifically related to the needs of the navy might be subserved at a small fraction of the cost involved in the maintenance of the Naval Observatory. The part it really plays is that of a great national observatory, and its material equipment is of a character befitting such a part. The President calls it "the most magnificent and expensive astronomical establishment in the world." Alongside its important observational work is carried on the Nautical Almanac, in connection with which the labors of Simon Newcomb and of George W. Hill have made American mathematical astronomy illustrious the world over. The whole of this activity should, as a matter of course, be presided over by an astronomer of the first rank, under a permanent tenure, and not by a man who, in the nature of the case, must be comparatively an amateur, and who is likely to look upon the post as a pleasant berth

rather than as a great scientific responsibility. —New York *Evening Post*.

THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

The report of President Maclaurin, of the Institute of Technology, derives rather unusual interest as a fresh contemplation of old problems. These include the annual equation of making receipts equal expenditures, and the new questions of better salaries for instructors and a new location for the institute. Difficulty appears in keeping some of the best of the teaching force in the face of larger professional opportunities. The margin is frequently too great to be offset by the teacher's enthusiasm, and an appeal is made to the state to deal more generously with this institution. The present plant is criticized because of the noise, dirt and electrical disturbance to which it is subjected. The buildings are scattered and inconvenient and lack dignity. If a removal to some more favorable location is not soon made in ten years it will be inevitable, in the president's opinion, and the longer it is delayed the more difficult will it be to find a suitable situation. —The Boston *Evening Transcript*.

SCIENTIFIC BOOKS

Consciousness. By Henry Rutgers Marshall, M.A., L.H.D. New York, The Macmillan Co. 1909.

The intending reader will take this book in hand with a certain feeling of satisfaction due to first impressions. As a piece of bookmaking it is exceedingly well put together; and the analytic table of contents shows that it is the intention of the author to treat the various problems which he chooses to include under its title in an orderly and systematic way. The promise made by these first impressions is in the main well fulfilled. Moreover, the style of the book, although it is not always clear and is in spots positively obscure, is uniformly dignified and appropriate—recognizing obligations and differing with self-restraint and sobriety, and without resort to those kaleidoscopic turns and twists of argument and tricks of rhetoric which have cost the would-be science of psychology so dearly in this country.

The author announces in the preface (p. vii) such a "restatement of psychological doctrine" as shall "bring all related psychic facts into harmony with the theory" which he has defended in some of his previous writings. With the expert student of these facts, such a statement as this is certain to create grave misgivings. For at this somewhat late day in the history of psychology, as of any other of the so-called sciences, the temptations connected with the attempt at restatement of all its facts are almost irresistible. Of these temptations the following two are chief: first, the temptation to think that one is saying something new, because one is telling the same old story in a different and not infrequently a more uncouth language; and second, the temptation to force the facts into harmony with the new theory, under cover of a difference in the language used to describe them. Let us not forget, then, that in the development of any science, *restatement* can not create any new facts or justify any new interpretation of facts already known. At best, it is only a matter of convenience in the method of arrangement and exposition. Of late in psychology, in our judgment, most similar attempts have hindered quite as much as they have helped the discovery and the elucidation of its more fundamental truths.

Mr. Marshall divides the treatment of his theme into three separate books. Of these, Book I. treats of Consciousness in General; Book II., of The General Nature of Human Presentations, and Book III., of The Self. Each of these books is again divided into parts, divisions, subdivisions, chapters and numerous short paragraphs—giving an appearance to the whole not unlike that of Spinoza's "Ethica." Thus the form of presentation is made to accord quite strictly with the plan which, as we have seen, proposes to restate all the psychic facts in terms of a new theory that shall embrace and explain them all. At this point, the devoted psychologist can scarcely refrain from the prayer: Would to heaven that the attempt might be successful!

Before examining any of the particular problems dealt with by the author, it is de-

sirable that we should form some preliminary conception of the general theory which is to prove a solvent for them all. This theory is by no means difficult to state. It is that all the phenomena of consciousness (the inclusive title which the book bears) may be explained as due to "presentations," and groups and smaller and larger systems of presentations, and of their present and past reactions on one another. In this principle, and indeed in not a few of its applications, Mr. Marshall's theory closely resembles, and is a sort of *replica* of, Volkmann von Volkmar, whose masterly treatise (one of the most notable works on psychology of the past century), in spite of all the ado made by writers on pedagogy over Herbart (and Volkmann is the finished product of Herbartianism) is scarcely known at all in this country. Volkmann, too, accounted for all the psychic facts in terms of the combinations of *Vorstellungen,* both in the field of consciousness and "below the threshold." Volkmann, too, made use of elaborate and abstruse algebraic formulas to set forth the forms and laws of the actions and reactions of the *Vorstellungen*—a device which Mr. Marshall uses sparingly (see, however, pp. 72 ff.), but helps out with more strictly architectural material in the shape of geometrical diagrams.

Thus far considered, the theory of the "systemic" nature of human consciousness, although it involves not a few highly conjectural elements, is essentially a psychological affair. For presentations, like *Vorstellungen,* are psychic facts, so far as they have any existence at all. And this is to say that our theory explains some psychic facts by other psychic facts. But an equally important side, or half, of the complete theory of Mr. Marshall's book is what the author calls "neururgic." These neururgic facts, which are to constitute this other half of the complete theory, are, of course, happenings in the human nervous system. As facts, they can be known only by prolonged and expert and purely "objective" research; and the sciences that discover and explain them are physiological chemistry, histology, physiology, etc. Now, thirty-five or forty years of devoted, although somewhat intermittent, study of the subject has convinced the writer of this critical review that all the attempts hitherto made to establish a scientific theory, at once precise and inclusive, of the relations between the "neururgic" facts and "all the psychic facts" prove on examination premature and even delusive. But in Chapter I., which treats of Noetic Correspondences, Mr. Marshall adopts a theory of complete parallelism between the two classes of facts. Every fact of sentience, even the unknown or the essentially unknowable, corresponds to some fact of a definite neururgic character. Nowhere, however, are we told what is the effective nature of this alleged correspondence.

In order to orientate ourselves the better for understanding the positions taken in the later chapters, let us pause a moment in the point of view held in this first chapter. From this point we behold two parallel lines drawn, which are to include within them the entire domain of the science of psychic facts. One of these lines—the psychic—consists in part of undoubted psychic phenomena, which are established in the only way in which such initial facts can be established; and this is by the awareness of the subject who experiences them. Such facts are, however, only spots, more or less detached from one another, in the total line. Between and surrounding them, are parts of the line which consist of psychic facts of which no one is ever directly aware, but which have a certain claim to reality because of the service they render as explanatory of undoubted facts; but the greater part of this line consists of purely conjectural occurrences, to which, although they are never in consciousness at all, terms are given the applicability of which can be verified or disproved only by self-consciousness. Parallel with this line is another—the so-called "neururgic"—the facts of which are of a quite different order, and which, as facts, are scarcely touched upon by our author; but the rest of this line—*i. e.,* the most of it—is made up of unverified and unverifiable conjectures. This becomes a case, then, where not only is the general theory conjectural (and yet of the

nature of a permissible hypothesis), but where the alleged facts are largely conjectured in support of the theory; and this along both the parallel lines—facts of sentience and facts called neuroses.

How this general theory works in its attempts to deal with definite psychological problems we shall now test in a number of selected particulars. We hasten to say that where Mr. Marshall approaches any psychological problem without emphasizing his general theory for explaining "all psychic facts" by correspondences between largely conjectural facts of sentience and almost wholly conjectural neururgic facts, he is much at his best. In such cases he shows the candor, learning and depth and breadth of insight, from the more general exercise of which an improvement of psychological science, now so severely threatened with disintegration and degradation, might reasonably be expected.

Mr. Marshall makes clearly and well the distinction between consciousness as sentience, the universal characteristic of all psychical life, and consciousness as the "awareness" of an object, whether percept of thing or consciousness of self. But, in our judgment, he weakens the value and mistakes the significance of this distinction when he speaks of "sub-attentive consciousness," and fails to see that some at least faint share in the distribution of attention is necessary in order that any particular part of the field of sentience may lay claim to being part of this field at all. Nor is this a point of no importance for our general psychological theory. For since all the earlier and simpler conative manifestations of mental life are connected with attention, the failure to recognize them on the lowest levels of this life renders the theory lacking in the prime requisite of all modern science; we will call it "*dynamic* quality." It is not surprising, then, that our author, having only presentations and systems of presentations to deal with, so frequently overlooks or minimizes the "energetics," or active aspect of—not the presentations, but of the being whose are the presentations.

Other particulars in Book I. with which we find ourselves in agreement are the "systemic" view of consciousness, as against all attempts to regard it as a "blooming confusion" or to ridicule the efforts to analyze it into elements or factors, if only these latter words are understood in accordance with the unity of consciousness; with what is said (p. 94 f.) about the unsatisfactory assumptions connected with the customary theory of the "association of ideas"; with the doctrine that pleasure and pain are not sensations, but "general qualities of all presentations"; and with the view that other than human consciousness is of necessity described and explained in terms of our consciousness.

We also note with peculiar satisfaction Mr. Marshall's discussion and rejection of the theory of Lange and James concerning the muscular and peripheral origin of the emotions (the central determining conditions of which we have ourselves discussed at great length, elsewhere); and as well, the unwarrantable and almost unintelligible contention of Stumpf and James that some special quality or specific element, to be called "extensity," belongs to the material content of every sensation. In a word, this first book, being, after the theory of parallelism is once stated, little burdened with that theory, is perhaps of all three books the most satisfactory.

Book II., which, as we have already seen, treats of The General Nature of Human Presentation, in its doctrine of their intensity and complexity, presents no features worthy of special attention. But the case is not the same with Mr. Marshall's views as to what he calls the "realness" of certain presentations. This qualification he seems to resolve into the one element of persistence or stability (pp. 221 ff.). It might properly be objected that many of the impressions of the *real*, both in ourselves and in outside objects, are among the most sudden, sharp and unstable of all our presentations. But the entire following discussion shows how inadequate is the basis laid in this way for the subtle, exceedingly complex and eminently intellectual and profoundly metaphysical, human conception which answers to the word "reality." Nor does the

somewhat dubious and partial acceptance of Professor James's theory of the will to believe as the creator of reality much help out the matter. More light would have been thrown on this obscure subject if the author had thoroughly worked out the suggestion received in a private letter from Professor Gildersleeve: "To the Greek the world was first 'Wille'; then 'Vorstellung.' The consciousness of the not-me comes from the putting forth of will." This most important truth, so early recognized by Greek thought, we have ourselves elaborated at great length in various writings, and as it appears both from the modern psychological and from the metaphysical points of view. It is worth mention in this connection, that the same view is extensively adopted by physicists who are interested in the psychological and metaphysical aspects of their particular science.

The physiological theory of the pleasure-pains, which resolves the fundamental difference in character and all the differences in the intensities of the two series, into the efficiency or inefficiency of the neural elements to respond to stimuli, like all similar theories, offers an explanation of only *some* of the phenomena. The discussion of the time concept, while it assumes the correct position that its entire basis in experience is given in the fact, that presentations actually occur in succession, is obscured by the use of the misleading term, the "specious present"—misleading, because the so-called *specious* present is the only *real* present; it is the actual "now" comprised within the grasp of consciousness. But the present conceived of as a mathematical point is not, and never can be, actualized. A similar misconception has been the source of a lot of silly puzzles, such as that of the inability of Achilles to overtake the tortoise, of the arrow to fly, etc, which have tormented the brains of men, to no good purpose, through centuries of misspent time. How often does the student of psychology, who wishes to arrive somewhere, wish also that such phrases as "specious present," "stream of consciousness," and many similar phrases, had never been born!

It is in his treatment of the Qualities of Relation (Chapter XIII.) that the author begins to show the more serious results of his general theory. So far as the relations of so-called presentations can be considered objectively, or better passively, no serious objection to the treatment is to be urged. On the contrary, it is, in several respects, excellent; but there is nowhere any clear recognition of the fundamental truth that relations between presentations, objectively considered, can come into existence only as the result of "discriminating consciousness," or the mind's relating activity. While, then, attention is again recognized as "a very general aspect of consciousness" (p. 314) and the statement that the distinction between involuntary and voluntary attention is largely, oftentimes, a matter of degrees is quite true; and while it must be admitted that attention is not all of will, although it is "the very essence of connation"; the general theory of psychic facts as due to correspondences between neururgic facts and facts of sentience, seems to us utterly to break down when it faces the experiences and the developments of man's intellectual life. *Thinking and the cognitive judgment can never be explained—and, indeed, the facts can not even be stated—in terms of either neururgics or the mechanism of presentations.*

But the inadequacy of the theory is more conspicuous when the attempt is made to explain in its terms the Object-Subject Relation (Chapter XV.). We are here told that it is "the correlation of realness (or stability) and manifoldness" of the presentations which gives us the object-subject relation (p. 345). But Mr. Marshall, who is usually so clear in style, becomes increasingly unclear, as he attempts to show us how a mere correlation in presentations can beget a self-consciously active "empirical ego." Nor does the already much over-worked function of "a will to believe" by any means serve to supply all the missing links between this machine-controlled field of conscious and unconscious presentations and a "real, live man." The obvious reason is that unless a will, that counts for something, is recognized at the start, it can

not be introduced afterward as the gift of either the nervous system or of the system of presentations.

No wonder, then, that when, in Book III., the same general theory is applied to the profound and difficult problems offered by such a conception as that of the human self, we come almost immediately upon the following statement (p. 475 and note): "We are bound thus to assume that all animals which experience a stream of presentations must have selves not fundamentally dissimilar from human selves." We refuse to recognize any such obligation. And this because we do not find that any semblance of a real self, human or otherwise, can be constructed by any system of presentations, no matter how manifold or skilfully compounded.

The book closes with discussions of the problems of moral responsibility and immortality. This seems to us the most interesting and suggestive part of the entire treatise. But the general theory is carried, in the attempt at a solution of these problems, to its consistent logical result. What appears to the self as free will, even when it culminates in choice, is but the triumph of the stronger over the weaker group of presentations. Character is the general fact that such, rather than other presentations, are accustomed to triumph in the conflict for realization of presentations in the successive fields of consciousness; its basis is laid in an inherited neururgic system. The empirical ego and the self, being a series of presentation compounds, can not, of course, reasonably maintain even the hope of an immortal life. In these important particulars, Mr. Marshall's views resemble more closely the Buddhistic doctrine of *Kharma* than those of western writers generally, when uninfluenced by oriental philosophy.

GEORGE TRUMBULL LADD

SOME NEW CHEMICAL BOOKS

An Elementary Treatise on Qualitative Chemical Analysis. By J. F. SELLERS, Professor of Chemistry, Mercer University, Georgia. Revised edition. Boston, Ginn & Co.

The revised edition of Professor Sellers's manual is a very good book. The author bases analytic reactions on the dissociation theory, and introduces a number of questions, answers and examples, showing the student in a very helpful way just how this theory explains so many phenomena met in analysis.

A Manual of Qualitative Chemical Analysis. By J. F. McGREGORY, Professor of Chemistry and Mineralogy in Colgate University. Revised edition. Boston, Ginn & Co.

The revised edition of Professor McGregory's manual is also a good, thorough, well-written book. The author does not think it advisable to introduce the dissociation theory at this stage, and prefers old well-tried methods of separation. Many teachers agree with him.

These two manuals—each excellent—are examples of radically different methods of teaching analysis. A few years ago an occasional book appeared written more or less (generally less) on physical-chemical lines. Now, as a matter of fact the reverse is true. Within the last few years some excellent methods of separation have been devised by Noyes and his co-workers and by others. The conservative manual, rejecting new theories and clinging to the old methods of analysis, is slowly disappearing. The same tendency is even more noticeable in elementary text-books of chemistry; the next three books we have under consideration are text-books, and while each is markedly different from the others all have the common factor of explaining the action of acids on bases and many other phenomena, by the dissociation theory.

Elementary Modern Chemistry. By WILHELM OSTWALD, Emeritus Professor of Chemistry in the University of Leipzig, and HARRY W. MORSE, Instructor in Physics in Harvard University. Boston, Ginn & Co.

Ostwald's little book is probably intended for schools; he touches only the leading facts in chemistry, omitting much that others would retain, while introducing many physical experiments which others would omit. Writers of quite elementary books generally reduce theory to a minimum; Ostwald makes the proportion of theory much greater in this

little book than in his "Grundlinien"; but Ostwald has the power of wording theory so that an intelligent boy not only can understand it, but will be fascinated by it. Hence this is an exceptionally good book for a school, and an ideal foundation for a modern college course. The experiments are simple and require little apparatus. The book is illustrated by excellent diagrams of apparatus and by portraits of leading chemists.

General Inorganic Chemistry. By CHARLES BASKERVILLE, Ph.D., Professor of Chemistry in the College of the City of New York. Boston, D. C. Heath & Co. Pp. 357.

This book differs from most text-books in three important particulars: it is not illustrated, it has scarcely any experiments, its arrangement is quite different from that usually adopted. As to its arrangement, after consideration of hydrogen, oxygen, water, the halogens, the alkali metals, nitrogen and carbon, comes the periodic law; then the elements are considered as such in the order of their grouping in the system; next come the hydrogen compounds of the elements, followed by the halides; chapters on molecular weights and dissociation come next, followed by chapters on the oxides, sulphides, hydroxides and hydrosulphides of the first three groups and part of those of group IV.; then come the carbonates of all the groups; then oxides of silicon, followed by the remaining oxides and sulphides of group IV. Enough of the contents has been given to show the plan of the work. Some teachers may prefer this sequence to that commonly followed. While the book is not large, it is well written, is distinctly original and replete with information.

A Course in Inorganic Chemistry for Colleges. By LYMAN C. NEWELL, Ph.D., Professor of Chemistry, Boston University. Boston, D. C. Heath & Co. 1909. Pp. 594.

This book is intended for the first year in college chemistry. It is well written, thorough, longer than most books of the same grade, but contains nothing too advanced; a part of the excess text is given to theory; electrolytic dissociation, reversible reactions, equilibrium, catalysis, vapor pressure, electrolysis and the behavior of dissolved substances are adequately treated. Still the book is mainly descriptive; descriptions of technical methods and the technical and practical uses of chemical compounds are allotted much more space than is usual. This is good, for a student should familiarize himself with these matters and the first year is the best time to study the outlines of applied chemistry.

Professor Newell's book is illustrated by excellent diagrams and by portraits of great chemists; it ranks among the best college text-books for the first year.

The Calculations of General Chemistry, with Definitions, Explanations and Problems. By WILLIAM J. HALE, Ph.D., Assistant Professor of Chemistry in the University of Michigan. New York, D. Van Nostrand Co. 1909.

The author intends this book on chemical arithmetic to accompany the first year's laboratory work in general chemistry; he says in the preface:

> In the manner of presentation a somewhat different plan has been followed from that usually found in books of this nature. This consists in a gradual introduction of each new condition properly falling under the consideration of some one subject, and the final development of the subject in its entirety from all the conditions thus considered.

The book is doubtless the best yet offered in this field, and should be carefully examined by college teachers.

The Romance of Modern Chemistry. A description in non-technical language of the diverse and wonderful ways in which Chemical Forces are at Work, and of their manifold application in Modern Life. By JAMES C. PHILIP, D.Sc., Ph.D., Assistant Professor of Chemistry, South Kensington College of Technology. London, Seeley & Co.; Philadelphia, J. B. Lippincott Co. 1909.

The cover of this work is multicolored and lurid; the headings in the table of contents suggest those in the daily papers; as—"How Artificial Alizarin has Ousted the Natural Dye from the Market—Natural Indigo Badly Hit—Synthetic *versus* Natural Camphor."

Cover and headings lead one to expect an unbalanced sensational book; this is not the case. The author seems to feel that to make his book interesting to the general reader he must occasionally try to be flippant and sprightly by using slangy colloquialisms. He may be assured that this is not necessary; he has an interesting story to tell and he tells it in a vivid, interesting way. The book is so good that it is a pity it should be marred by these blemishes, and if the author would cut them out in his next edition his book and its readers would be gainers.

The title-page describes the plan of the book; it suggests Lassar-Cohn's famous "Chemistry in Daily Life," which is written on similar lines, but each contains much that the other does not. It is well illustrated and should be welcome to libraries and to the general reader.

EDWARD RENOUF

Exercises in Physical Chemistry. By W. A. ROTH, a. o. Professor of Physical Chemistry in Greifswald; translated by A. T. CAMERON. New York, D. Van Nostrand Co. $2.00.

This book, embodying, as the author states, the practical course used in Professor Nernst's laboratories, needs no words of praise. Well-chosen experiments are described with full details and due emphasis is laid on consideration of sources of error, methods of calculation, theory of phenomena involved and all that a beginner needs to be told in order to gain the real educational value of the work.

A Text-book of Physical Chemistry; Theory and Practise. By ARTHUR W. EWELL, Assistant Professor of Physics, Worcester Polytechnic Institute. Philadelphia, P. Blakiston's Son & Co. $2.25.

If this book has a fault, it suffers from "the last infirmity of noble minds," extravagant ambition. Within the scope of 360 pages the author attempts to give "a laboratory manual, a text-book" and a "convenient book of reference." Considering the nature of his task, the author's success is remarkable, though it suggests strongly the breathless haste of the inexperienced tourist trying to "do" all Europe in three months. As a laboratory manual the directions are hardly full enough; a text-book, in the sense of a book from which the average student could, if necessary, educate himself, it certainly is not; as a work of reference it should prove useful to general students who can not afford to buy larger works. But rather than any of these it resembles those sheets of "lecture notes" which many teachers give their students for purposes of review and as such it is unusually excellent. Statements of fact are almost uniformly correct and theoretical demonstrations, though concise, are adequate, and do not, as in so many similar works, shirk the use of elementary calculus. The author evidently has a thorough grasp of his subject, and, as is shown by a judicious selection of references, a first-hand acquaintance with the literature. But some experience of college and university students causes the reviewer to wonder whether one man in a score could assimilate without mental indigestion, all the contents of this book in less than three or four years of undergraduate study. Expanded to three times the size and properly peptonized it would make one of the best text-books in the English language for post-graduate students specializing in physical chemistry.

B. B. TURNER

The History of the Teaching of Elementary Geometry, with Reference to Present-day Problems. Submitted in partial fulfilment of the requirements for the degree of doctor of philosophy in the Faculty of Philosophy, Columbia University. By ALVA WALKER STAMPER. Pp. x + 163. (Preface dated 1906.)

Comparatively few scholars in the United States are selecting the history of their chosen science as a subject of research. For that reason it is an unusual pleasure to welcome the author of this monograph into the ranks of historians of science. Much has been published on the history of geometry, but the book under review is the first devoted to the history of the *teaching* of elementary geometry. Naturally, one could not trace the history of the teaching of geometry without making frequent references to the history of

the science itself. Especially is this true of the Greek period, in which all data about teaching are closely interwoven with statements relating to geometrical research. Dr. Stamper devotes the first three chapters to the Greeks, Romans and Orientals, one chapter to the Middle Ages, one long chapter to the seventeenth, eighteenth and nineteenth centuries, and two chapters to present-day teaching. The last three chapters contain much that is original with the author. Teachers of geometry will find them suggestive and valuable. Texts have been examined to which no references are usually found in histories. Doubtless it is more difficult to secure data on the teaching than on the progress of a science. In illustration of the difficulty of securing data on teaching we refer to the author's acknowledged inability to fix the time when Euclid began to be used as a text-book in English secondary schools within a closer range than three quarters of a century. Dr. Stamper claims that in England there were no texts on the practical side of geometry, nor any combining the practical with the logical, such as prevailed on the continent up to about the middle of the seventeenth century. We doubt the accuracy of this statement. The present writer has before him books explaining the use of the slide rule by William Oughtred (1660, 1st ed., 1632), Seth Partridge (1662), Hunt (1697), Everard (1705), Leadbetter (1755), which may certainly be classed among works of practical geometry. These books offer fine examples of the correlation of geometry with arithmetic and trigonometry. The title-page of Coggeshall's book refers to the "Use of Scamozzi's Lines, for finding the Lengths and Angles of Hips, Rafters, etc., at any Pitch, in Square, Beveling or Tapering Frames," explained by John Ham, mentioned later in the text as "Master of the Mathematical School at the Chapel in Hatton-Garden, Holborn." The book contains also a regular "compendium of practical geometry." Nor must we forget John Ward's "Young Mathematician's Guide" (1707) where, out of a total of 427 pages, 64 are given to geometry, the subject being treated in a manner quite remote from Euclid's. In 1771 this text reached its twelfth edition. In the preface we read:

> This treatise hath proved a very helpful Guide to near five thousand persons; and perhaps most of them such as would never have looked into mathematicks at all but for it. . . . And not only so, but it hath been very well received amongst the Learned, and (I have often been told) so well approved on at the Universities, in England, Scotland, and Ireland, that it is ordered to be publickly read to their pupils.

In this country Ward's text was used at Harvard College as early as 1737, and as late as 1787 at Yale and Dartmouth.

While the author worked industriously, there are some gaps in his history. For instance, no reference is made to the texts of Basedow and his efforts at reform, nor to the remarkable works of Louis Bertrand. Nor has he used all the available secondary sources of information, such as J. H. Graf's history of mathematics in Bern and L. Isely's history of mathematics in the French part of Switzerland.

The book lacks an alphabetical index, but has a full table of contents and a list of the original and secondary sources used in its preparation. This list will be welcomed by all who may desire to undertake research work on the teaching and history of elementary geometry.

FLORIAN CAJORI

A Treatise on Zoology. Edited by Sir E. RAY LANKESTER. Part I., Introduction and Protozoa. First Fascicle, by S. J. HICKSON, J. J. LISTER, F. W. GAMBLE, A. WILLEY, H. M. WOODCOCK, E. RAY LANKESTER and the late W. F. R. WELDON. Pp. ix–xxii + 296; 151 figs. London, A. & C. Black. 1909.

The present volume, together with the previously published second fascicle dealing with Foraminifera, Sporozoa and Infusoria, completes the account of Protozoa in Lankester's well-known "Treatise on Zoology." The Proteomyxa and Lobosa are described by S. J. Hickson; the Heliozoa by the late W. F. R. Weldon and S. J. Hickson; the Mycetozoa by J. J. Lister; the Radiolaria by F. W.

Gamble; the Mastigophora by A. Willey and S. J. Hickson; the Hæmoflagellates by H. M. Woodcock, while descriptions of Chlamydomyxa and Labyrinthula written by J. J. Lister, form an appendix.

There is little to be said on the whole in regard to the descriptions of the majority of the articles. The section on Hæmoflagellates contains many important facts regarding hosts and parasites, otherwise it differs little from Woodcock's original article in the *Q. J. M. S.*, 1906. It is remarkable, however, that Spirochæta and Treponema are not mentioned in the account of the Mastigophora and that these most widely studied of all protozoan parasites should be passed by with only a short statement in an appendix to the Hæmoflagellates. All of the articles are fairly clear and well-written expositions of the structures and modes of life of the several types of Protozoa, but with the exception of the sections on Mycetozoa and Radiolaria there is little that is new or above the average of an ordinary text-book, while there are few references to literature later than 1906. With the Mycetozoa and the Radiolaria, however, there is no savor of mediocrity. Here the descriptions of structures and life histories are written with reference to the problems in general biology with which the protozoa have the most to do, and with a philosophical breadth of view as refreshing as it is novel.

While the book makes no pretense of arranging the various groups of Protozoa in any way that might be construed as showing phylogenetic relationships of the unicellular animals, it does seem peculiar and unnecessary to separate Heliozoa completely from Radiolaria and insert a section on Mycetozoa between them. As long as the organs of locomotion of Protozoa are accepted as indicating the natural limits of a group, consistency at least should be exercised to keep the undoubted close relations of these two groups before the eyes of the student. There is some danger, too, of the latter becoming so tangled up in a maze of unfamiliar terms that he might well wish to get away from the subject as soon as possible and leave the Protozoa to pedants. He finds that "koniokaryote" protoplasm superseded the condition of "plasson"; that the well-known and well-understood term "cytoplasm" must be replaced by the unfamiliar word "periplasm," and his brain whirls with the confusion of "gubernaculum," "tractellum," "pulsellum," while his ideas of the fixity of biological conceptions get sadly twisted in trying to discover why nature ever made the mistake of allowing a "tractellum" to act as a "pulsellum," or a zoologist to go backwards twenty-five years and classify *Volvox* as a protozoon!

As with all the volumes of this treatise the type, page and illustrations are excellent, the latter being well drawn, clearly reproduced, and many of them unusual as text-book figures. The paper is altogether too thick and clumsy however, making a heavy and poorly bound volume, which will never stand the wear of ordinary use.

G. N. C.

SCIENTIFIC JOURNALS AND ARTICLES

The Journal of Biological Chemistry, VI., No. 6, issued November 12, 1909, contains the following: "The Purines and Purine Metabolism of the Human Fetus and Placenta," by H. Gideon Wells and Harry J. Corper. A study showing the independent development of the various purine enzymes during the growth of the fetus and indicating active metabolism in the placenta. "Soluble Chitin from *Limulus polyphemus* and its Peculiar Osmotic Behavior," by C. L. Alsberg and C. A. Hedblom. Prolonged treatment of *Limulus* chitin with HCl produces soluble chitin which has the peculiar power of dialyzing and of carrying the water in which it is dissolved through the membrane. "Some Observations on the Study of the Intestinal Bacteria," by A. I. Kendall. An outline of general procedures applicable to the determination of the more important types of bacterial activity in the intestinal tract. "A Study of the Chemistry of Bacterial Cellular Proteins," by Sybil May Wheeler. A comprehensive study of bacterial proteins from various sources, their properties, the nature and amounts of their cleavage products together with accounts of efforts to

isolate and identify the toxic elements in them.

SPECIAL ARTICLES

THE GEOLOGICAL AND GEOGRAPHICAL DISTRIBUTION OF SOME PLEISTOCENE MAMMALS

Some months ago Professor Henry F. Osborn, of the American Museum of Natural History, published[1] an important paper entitled "Cenozoic Mammal Horizons of Western North America." Having had occasion recently to consider some phases of the Pleistocene I have examined with interest the part of Professor Osborn's paper devoted to this period.

Professor Osborn has been giving attention to Tertiary history and correlation for many years. In 1900[2] he published his "Correlation between Tertiary Mammal Horizons of Europe and America," in which he devoted eleven pages to a consideration of the Pleistocene. In connection with this he issued a "Third Trial Sheet," in the preparation of which he had the assistance of several European geologists and paleontologists. The paper and the trial sheet dealt more especially with European history. The paper of 1909, put forth after nine years' further investigation on the part of Professor Osborn, during which time numerous other paleontologists and geologists had occupied themselves with Pleistocene studies, presents more fully the American side of the problems.

In Professor Osborn's treatise of 1900 he and his collaborators recognized fully the work that had been done by geologists in their determination of the existence, in Europe, of more than one sheet of glacial accumulations and one or more interglacial deposits. In the communication of 1909, on the contrary, Professor Osborn makes no mention of the great advances that have been made within recent years in the knowledge of the Glacial epoch in North America, resulting in the discovery of four or five distinct glacial sheets and a corresponding number of interglacial deposits of soils, peat beds, gravels and sands, with their organic contents. His bibliography of the Pleistocene (pp. 17, 18) contains no references to such authors as Bain, Calvin, Chamberlin, Dawson, Leverett, Lewis, Salisbury, Tyrrell and others whose works have been of the highest value in the solution of many problems connected with Pleistocene history. And it may be affirmed with confidence that without giving due consideration to glacial geology no correct solution of the paleontology of the Pleistocene is possible.

It appears to have been Professor Osborn's intention to divide the Pleistocene into the Lower, or Preglacial; the Middle, or Glacial, and the Upper, or Postglacial; although he does not mention the last division. We need not here discuss the propriety of recognizing a preglacial stage of a period that has little or nothing to distinguish it from the Pliocene, except the presence of glaciers. On page 87 of Bulletin 361 is a table showing the approximate times of appearance and disappearance of certain important genera of mammals. It is an unfavorable comment on our knowledge of the Pleistocene, when all that can be said of six important genera is that they disappeared at some time during the Glacial period. It is my belief that the history of some of the interesting animals concerned can be determined somewhat more accurately. A beginning will be made with *Equus*, the horses, a genus which Osborn says disappeared from North America during the "upper mid-Pleistocene," a time which unfortunately he does not limit either downward or upward.

If now we indicate on a map all of the apparently authentic finds of fossil horses in the United States east of the great plains, we learn that, starting in New Jersey, one series of localities arranges itself along the Atlantic and the Gulf coasts, while the other, with a few important exceptions, follows an irregular line through Pennsylvania, Ohio, Indiana, Kentucky, Illinois, Missouri, Iowa and South Dakota. A comparison with a map showing the glaciated region of the country indicates that the localities of the last series (barring the few exceptions) are situated close to the southern border of the drift-covered area.

The earliest discovery of fossil horse re-

[1] Bull. U. S. Geol. Surv., 361, pp. 1–90.

[2] *Ann. N. Y. Acad. Sci.*, XIII., pp. 1–64.

mains was made near the Neversink Hills in New Jersey, a considerable distance south of the drift-covered region. Other remains have been found near Philadelphia, likewise south of the drift. Teeth and bones of two species of horses were discovered in Port Kennedy cave, but this too lies south of the glaciated tract. Two teeth of an extinct horse were found in the banks of the Susquehanna River, at Pittston, Pennsylvania, some twenty miles north of the terminal moraine; but Leverett shows by his map[3] that just south of Pittston there is a much older drift sheet. The teeth in question may therefore have been buried in this layer or even below it, in preglacial deposits which may continue north as far as Pittston.

Further west, remains of horses have been found at Cincinnati and at Big Bone Lick. These localities are within the border of the Illinoian drift sheet and possibly the remains are in an interglacial deposit below the drift, inasmuch as at Cincinnati they were obtained several feet below the surface of the drift. Scanty remains of a horse have been discovered near Evansville, Ind.; but this is outside of the glaciated area. The same is to be said regarding two localities in Missouri.

Many years ago Dr. Skilton called attention to some horse teeth that had been found near Troy, N. Y., but there is nothing in the case to make us suppose that they were anything else than the teeth of the domestic horse. Two teeth of a fœtal or new-born horse have been reported by Leidy from Hartmann's cave, near Stroudsburg, Pa. This cave is situated eight or nine miles north of the glacial moraine. Inasmuch as the cave had long been open, so that boys had been accustomed to explore it, the colt teeth may have been rather recently introduced by some carnivorous animal. A more reliable discovery was made many years ago in a bog near the line between Bond and Fayette counties, Ill. From this place Worthen sent to Leidy the maxillary bone, with the four premolars, of a horse which Leidy identified as *Equus complicatus*. Through the kindness of Dr. A. R. Crook, curator of the state museum, at Springfield, I have had the opportunity of examining the specimen and have had the benefit of the expert knowledge of Mr. Gidley. Neither the bone nor the teeth are to any considerable extent mineralized. The teeth have the enamel somewhat more complicated than it is in any known specimen of the domestic horse, but it does not have the thickness indicated in Dr. Leidy's figure of the specimen. The teeth have almost exactly the structure shown in a thoroughly fossilized tooth found at Big Bone Lick and sent by Dr. Crook. The specimen may therefore be regarded as belonging to an extinct horse, probably *E. complicatus*. All that part of Illinois is covered over by the Illinoian drift sheet and since the tooth lay on this drift it must be younger than the Illinoian. It may belong to the Sangamon interglacial deposit. If so, the genus continued to about the middle of the Glacial epoch.

Dr. W J McGee[4] mentioned the finding of a tooth of *Equus complicatus* in northeastern Iowa. In reply to my inquiry Dr. McGee kindly informs me that the tooth was found near Sandspring, Delaware County, Ia., lying on a knoll of Niagara limestone. According to the geological map of this county, the immediate region is covered with Iowan drift, which overlies Kansan drift, but with intervening interglacial gravels and sand. Little of these sheets, except some coarse materials, was left on the wind-swept knoll. In case the tooth had been originally buried in or above the Iowan drift it would hardly have endured the weathering incident to being lowered to the limestone.

Mr. McAdams[5] reported the discovery of a tooth of a horse at the bottom of a well that was being dug in Greene County, Ill. The exact locality was not given. All that region is covered by Illinoian drift. The tooth may have been buried in an interglacial deposit below this. The same writer reported another tooth from Alton, Ill., but no details were given.

[3] Mon. U. S. Geol. Surv., XLI., Pl. II.

[4] Eleventh Ann. Report U. S. Geol. Surv., p. 495.

[5] *Trans. St. Louis Acad.*, IV., p. lxxx.

A remarkable discovery of vertebrate fossils in localities covered over by glacial drift has recently been detailed by Professor Samuel Calvin.[6] Two species of horses, five proboscidians, a camel, mylodon, megalonyx and other extinct mammals are described. The localities are not far from the Missouri River. These remains were buried in the soils belonging to the Aftonian interglacial stage, which preceded the Kansan ice sheet. Therefore, they come to us from near the beginning of the Glacial epoch. It is a fact which may be noted here that, although a large part of Iowa and a part of Kansas are covered by the Kansan drift sheet, which offers facilities for observation and which has been studied closely by geologists for many years, no bones or teeth of fossil horses have yet, so far as I can discover, been found on its surface. Nor have any been found on the surface of the Iowan drift or in it. Nor are there any reliable evidences that remains of horses have been found in those regions that are occupied by glacial deposits belonging to the early and the late Wisconsin stages.

The conclusion reached by the writer from the data at hand is that horses became extinct in the glaciated regions of North America, and probably in the larger part or the whole of the continent, about the middle of the Glacial epoch, the Bond County, Ill., specimen being the only one which indicates with some degree of certainty the existence of the genus *Equus* after the Illinoian stage.

Osborn[7] states that our knowledge of the Lower Pleistocene is still confined to the western plains and mountains, while he regards the fauna of the Port Kennedy cave, in Pennsylvania, as illustrating an early phase of the mid-Pleistocene. Now, 80 per cent. of the mammals of this cave belong to extinct species. The Cromer Forest beds, arranged by Osborn in the Pleistocene, by many authors, as Geikie, Lapparent, etc., in the Pliocene, contain, according to Clement Reid, 45 land mammals, of which 21, or about 46 per cent., are extinct. We might, I think, with reason hold that the mammals of the Port Kennedy cave belong to the Pliocene. There seem to be no good grounds for regarding them as more recent than the fauna of the Equus beds of the Great Plains. Calvin's discovery of the mammals of the Aftonian seems to bring the Equus beds up into the lower part of the Glacial epoch, thus abolishing the Preglacial stage. On the other hand, glaciation in North America may have set in earlier than in Europe. Our Equus beds, though interglacial, may nevertheless be also Pliocene.

We may here consider the probable age of the animals collected by Mr. Barnum Brown in the Conard fissure, Newton County, Ark. Mr. Brown has determined 51 species of mammals, of which 24, or about 47 per cent., are extinct, a ratio almost the same as in the case of the land mammals of the Cromer Forest beds. Evidently they belonged to a much later time than those which perished in the Port Kennedy cave. A few of the species seem to indicate a mild climate; most of them, as the wapiti, the musk ox and several burrowing species, show that the climate was rather rigorous. Evidently some one of the glacial ice sheets had pushed down boreal forms into contact with those of a warmer region. The Kansan ice sheet approached within about 200 miles of the fissure. The time of that sheet seems, however, too remote that more than a moiety of the mammals should yet be with us. It is more probable that those remains were assembled in the fissure during the Illinoian stage. The horse was yet in existence. The absence of the large edentates may be due to their extinction at that time or to their expulsion from the region by the low temperature. The bones and teeth of mammoths and mastodons, which certainly were in existence then, were probably too large to be dragged into the fissure.

There is space to consider only a few of the other genera noted by Osborn. The genus *Cervus* is put down as entering the country late in mid-Pleistocene time. However, the wapiti has been reported from a number of localities, among them Big Bone Lick and the

[6] *Bull. Geol. Soc. Amer.*, Vol. 20, pp. 341–356, pls. 16–27.

[7] Bull. 361, p. 84.

Conard fissure. *Rangifer* is stated by Osborn on page 86 as not appearing in the mid-Pleistocene, but on page 87 as coming in late. According to Shaler, *R. tarandus* seems to have been abundant in the older deposits of Big Bone Lick and a species of caribou has been found at Muscatine, Iowa. The late mid-Pleistocene age of the part of the loess containing the *Rangifer* bones is yet to be proved. *Ursus* is a third genus said by Professor Osborn to be a late comer in glacial times. One or two species of the genus were reported from Port Kennedy cave. Two species of the genus, one not distinguishable by Dr. Leidy from the common black bear, were found near Natchez, Miss., in the loess. Shimek, who has made a special study of the loess at Natchez,[8] says that "the solid blue clay," in which the vertebrates of that section have been found, probably does not belong to the loess, but is older still. How old it is no one knows.

According to the table cited above, the two species of mammoth, *Elephas columbi* and *E. primigenius,* disappeared during the mid-Pleistocene, while the mastodon perished during the "upper mid-Pleistocene." Now, northwestern Ohio, northern Indiana and southern Michigan are deeply covered over by a thick mantle of drift materials that was deposited by the Late Wisconsin ice sheet, the very last of the glacial advances. In depressions left on the surface after the retreat of this sheet there were formed lakes and ponds that afterwards became more or less completely filled up, forming marshes, peat bogs and swales. In ditching such places there have frequently been found the teeth and bones, sometimes nearly complete skeletons of the two elephants and of the mastodon. The fine specimen of *E. columbi,* now in the American Museum at New York and described by Professor Osborn, was found in just such a situation. It would be very difficult to prove that the mastodon survived the mammoth. It is certain that both the elephants and the mastodon continued to inhabit the Mississippi Valley long after the glaciers had abandoned the region and therefore during at least a part, if not the whole, of the Postglacial stage of the Pleistocene.

Oliver P. Hay

[8] *Bull. Lab. Nat. Hist.,* Iowa Univ., V., p. 307.

CATALYTIC ACTION OF IRON SALTS

Gibbs[1] has shown that the red coloration of phenol is due to oxidation brought about by the catalytic action of sunlight. The oxidation products condense and form red substances, as for example, phenoquinone.

As Dr. Fenton has shown that oxygen and sunlight are equivalent to hydrogen peroxide and a trace of a ferrous salt in their oxidizing action upon organic compounds, it struck me that the catalytic action of iron might be studied colorimetrically by resource of Gibb's work.

A concentrated solution of phenol in benzene was divided into three equal parts. The first was exposed to sunlight for two days, the second was treated with a small quantity of hydrogen peroxide, and to the third were added a trace of ferrous sulphate, and then the same quantity of hydrogen peroxide as was added in the second case.

No change could be seen in the first, the second almost immediately developed a very slight pink coloration, but the third at once changed to a reddish-brown color.

Blank experiments were made to show that the color was not due to benzene. Again, in order to prove that the color was not due to the iron alone, traces of a ferrous and a ferric salt were added to a similar benzene solution (without the hydrogen peroxide) when a greenish color was produced, which in no way could be associated with the reddish-brown color caused by iron and peroxide.

Further experiments showed that by means of the above reagents many of the laws of catalysis could be actually demonstrated to a large class in a lecture. More especially because the action was rapid and could be followed by the production of color. For example, to prove in a rough manner that catalysis can not affect the final equilibrium, the two differently colored solutions (one containing traces of iron and the other not)

[1] *Philipp. J. Sci.,* 1909, 4, 133.

are stood aside for a time, when it will be seen that they have both acquired exactly the same color, although the acquisition of it was more rapid in the solution which contained the trace of ferrous sulphate.

Lastly, it has been suggested that the iron merely brings about the catalytic decomposition of the peroxide (if such is the case, as Dr. Fenton has pointed out, why should not other salts produce the same effects?), and this suggestion seems at first sight to be confirmed by the fact that when the solution containing no iron is warmed (thereby bringing about the thermal decomposition of the peroxide, the result of which is just the same as that of "catalytic" decomposition) the color is developed with the same velocity as in the case of the cold solution containing traces of ferrous sulphate.

W. J. S. Naunton

THE CONVOCATION WEEK MEETINGS OF SCIENTIFIC SOCIETIES

The American Association for the Advancement of Science and the national scientific societies named below will meet at Boston, Mass., during convocation week, beginning on December 27, 1909.

American Association for the Advancement of Science.—Retiring president, Professor T. C. Chamberlin, University of Chicago; president, Dr. David Starr Jordan, of Stanford University; permanent secretary, Dr. L. O. Howard, Cosmos Club, Washington, D. C.; general secretary, Professor Dayton C. Miller, Case School of Applied Science, Cleveland, Ohio.

Local Executive Committee.—H. W. Tyler, chairman; Thomas Barbour, J. S. Kingsley, Edward R. Warren, John Warren, George W. Swett, secretary.

Section A, Mathematics and Astronomy.—Vice-president, Professor Ernest W. Brown, Yale University; secretary, Professor G. A. Miller, University of Illinois, Urbana, Illinois.

Section B, Physics.—Vice-president, Dr. Louis A. Bauer, Carnegie Institution, Washington, D. C.; secretary, Professor A. D. Cole, Vassar College, Poughkeepsie, N. Y.

Section C, Chemistry.—Vice-president, Professor William McPherson, Ohio State University; secretary, C. H. Herty, University of North Carolina, Chapel Hill, N. C.

Section D, Mechanical Science and Engineering.—Vice-president, Professor John F. Hayford, Northwestern University; secretary, G. W. Bissell, Michigan Agricultural College, East Lansing, Mich.

Section E, Geology and Geography.—Vice-president, Reginald W. Brock, Canadian Geological Survey; secretary, F. P. Gulliver, Norwich, Conn.

Section F, Zoology.—Vice-president, Professor William E. Ritter, La Jolla, Cal.; secretary, Professor Morris A. Bigelow, Columbia University, New York City.

Section G, Botany.—Vice-president, Professor David Penhallow, McGill University; secretary, Professor H. C. Cowles, University of Chicago, Chicago, Ill.

Section H, Anthropology.—Vice-president, Dr. W. H. Holmes, Bureau of American Ethnology; secretary, Dr. George Grant MacCurdy, Yale University, New Haven, Conn.

Section I, Social and Economic Science.—Vice-president, Byron W. Holt, 54 Broad St., New York City; secretary, Dr. John Franklin Crowell, 44 Broad St., New York City.

Section K, Physiology and Experimental Medicine.—Vice-president, Professor C. S. Minot, Harvard Medical School; secretary, Dr. Wm. J. Gies, College of Physicians and Surgeons, Columbia University, New York City.

Section L, Education.—Vice-president, Dean James E. Russell, Columbia University; secretary, Professor C. R. Mann, University of Chicago, Chicago, Ill.

The American Society of Naturalists.—December 29. President, Professor T. H. Morgan, Columbia University; secretary, Dr. H. McE. Knower, University of Toronto, Toronto, Can. *Central Branch.* President, Professor R. A. Harper, University of Wisconsin; secretary, Professor Thomas G. Lee, University of Minnesota, Minneapolis, Minn.

The American Mathematical Society.—December 28–30. President, Professor Maxime Bôcher, Harvard University; secretary, Professor F. N. Cole, 501 West 116th St., New York City.

American Federation of Teachers of the Mathematical and Natural Sciences.—December 27, 28. President, Professor H. W. Tyler, Massachusetts Institute of Technology; secretary, Professor C. R. Mann, University of Chicago, Chicago, Ill.

The American Physical Society.—President, Professor Henry Crew, Northwestern University; secretary, Professor Ernest Merritt, Cornell University, Ithaca, N. Y.

The American Chemical Society.—December 27–31. President, Dr. Willis R. Whitney, General Electric Company, Schenectady, N. Y.; secretary, Professor Charles L. Parsons, New Hampshire College, Durham, N. H.

The Geological Society of America.—December 29, 31. President, Dr. G. K. Gilbert, U. S. Geological Survey; secretary, Dr. E. O. Hovey, American Museum of Natural History, New York City.

The Association of American Geographers.—December 30–January 1. President, Professor W. M. Davis, Harvard University; secretary, Professor Albert P. Brigham, Colgate University, Hamilton, N. Y.

The American Society of Vertebrate Paleontologists.—December 27–29. President, Dr. J. C. Merriam, University of California; secretary, Dr. E. S. Riggs, Field Museum of Natural History, Chicago, Ill.

The American Society of Biological Chemists.—December 28–30. President, Professor Otto Folin, Harvard Medical School; secretary, Professor William J. Gies, 437 West 59th St., New York City.

The American Physiological Society.—December 28–30. President, Professor W. H. Howell, Johns Hopkins University; secretary, Dr. Reid Hunt, Hygienic Laboratory, 25th and E Sts., N. W., Washington, D. C.

The Association of American Anatomists.—December 28–30. President, Professor J. Playfair McMurrich, University of Toronto; secretary, Professor G. Carl Huber, 1330 Hill St., Ann Arbor, Mich.

The Society of American Bacteriologists.—December 28–30. President, Dr. J. J. Kinyoun, Washington, D. C.; secretary, Dr. Norman MacL. Harris, University of Chicago, Chicago, Ill.

The American Society of Zoologists.—Eastern Branch, December 28–30. President, Professor Herbert S. Jennings, Johns Hopkins University; secretary, Dr. Lorande Loss Woodruff, Yale University, New Haven, Conn.

The Entomological Society of America.—December 29, 30. President, Dr. Henry Skinner, Philadelphia, Pa.; secretary, J. Chester Bradley, Cornell University, Ithaca, N. Y.

The Association of Economic Entomologists.—December 28, 29. President, Professor W. E. Britton, Connecticut Agricultural College; secretary, A. F. Burgess, U. S. Department of Agriculture, Washington, D. C.

The Botanical Society of America.—December 28–31. President, Professor Roland Thaxter, Harvard University; secretary, Professor D. S. Johnson, Johns Hopkins University, Baltimore, Md.

American Nature Study Society.—January 1. President, Professor C. F. Hodge, Clark University; secretary, Professor M. A. Bigelow, Teachers College, Columbia University, New York City.

Sullivant Moss Society.—December 30. President, Professor Bruce Fink, Miami University, Oxford, O.; secretary, Mrs. Annie Morrill Smith, 78 Orange St., Brooklyn, N. Y.

Wild Flower Preservation Society.—President, Professor Chas. E. Bessey; secretary, Dr. Charles Louis Pollard, New Brighton, N. Y.

The American Psychological Association.—December 29–31. President, Professor Charles H. Judd, University of Chicago; secretary, Professor A. H. Pierce, Smith College, Northampton, Mass.

The American Anthropological Association.—December 27–January 1. President, Dr. W. H. Holmes, Bureau of Ethnology; secretary, Dr. Geo. Grant MacCurdy, Yale University, New Haven, Conn.

The American Folk-lore Society.—Week of December 30. President, Dr. John R. Swanton, Bureau of American Ethnology; acting secretary, Dr. R. B. Dixon, Peabody Museum, Cambridge, Mass.

Association of Mathematical Teachers in New England.—December 28. President, Charles A. Hobbs, Watertown, Mass.; secretary, George W. Evans, Charlestown High School, Boston, Mass.

Physics Teachers of Washington, D. C.—Meets in conjunction with American Federation of Teachers. President, W. A. Hedrick, McKinley High School, Washington, D. C.; secretary, Dr. Howard L. Hodgkins, George Washington University, Washington, D. C.

American Phytopathological Society.—December 28–30. President, Dr. L. R. Jones, University of Vermont; secretary, Dr. C. L. Shear, U. S. Department of Agriculture, Washington, D. C.

American Alpine Club.—December 30. Secretary, Dr. Henry G. Bryant, Room 806 Land Title Building, Philadelphia, Pa.

American Breeders' Association.—Meeting of Eugenics Committee. Secretary, Dr. Chas. B. Davenport, Cold Spring Harbor, N. Y.

SOCIETIES AND ACADEMIES

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

THE 670th meeting was held in the West Hall of George Washington University on November 6, 1909, President Wead presiding. Two papers were read.

The Application of the Electrical Resistance Thermometer to Pyrheliometry: Professor C. F. MARVIN, of the U. S. Weather Bureau.

Absolute measurements of solar radiation by the use of actinometers, or pyrheliometers, of the Pouillet type, in which the heating and cooling of a short copper cylinder, more or less filled with mercury, alcohol, etc., can not be made with satisfactory accuracy because of the unequal distribution of heat throughout the mass of the block, the differences in specific heat of the component parts, and the uncertainty as to the exact mass of material involved in the observed temperature change.

Most of the difficulties of the problem are minimized or eliminated by the use of the electrical resistance thermometer. For this purpose a short cylinder is formed, about three centimeters in diameter and a half centimeter long, by winding up two layers of very thin ribbon of pure nickel. Layers of very thin silk insulate the coils of nickel from each other, and the whole is cemented by shellac.

The nickel ribbon serves the double purpose of constituting the substance which receives and absorbs the solar radiation to be measured, and, by its large variation of electrical resistance with temperature, it is itself the thermometer that shows its own mean temperature.

The new construction enables the mass and the specific heat of the block to be determined directly.

A pyrheliometer with equatorial mounting and mechanism for operating the shutter by electrical control was exhibited. The auxiliary apparatus for the electrical measurement of temperature was also explained. Plans were described for measuring the amount of radiation which unavoidably falls upon the instrument from a greater or less portion of the sky within 5° or 10° from the sun.

Tentative preliminary observations using a copper block with a nickel-wire thermometer coil imbedded therein gave results from 6 to 10 per cent. lower than the Ångström pyrheliometer. The specific heat of the block was not accurately known.

Seasonal and Storm Vertical Temperature Gradients: Dr. W. J. HUMPHREYS, of the U. S. Weather Bureau.

About one hundred and fifty sounding balloon records, obtained in Europe, were grouped and arranged according to season and to the height of the barometer. On plotting temperature against altitude it was found that during the summer the atmosphere was warmer than in the winter at all levels from the surface of the earth to the greatest altitude reached; or, that seasonal changes in temperature extend to all sounded altitudes. The grouping of the records according to the height of the barometer showed that during the summer a barometric high commonly is accompanied by air which relative to that in a low, is warm from the ground up to about ten kilometers, or to just below the isothermal layer; but that in the isothermal layer it is relatively cold. During the winter the same relations hold at all levels except near (within two kilometers) the surface of the earth where the air is colder when the barometer is high than when it is low.

Presumably these results are not due to mere pressure differences, but rather to the amount of moisture in the atmosphere which is greatest generally when the barometer is low. This moist air, being a good conductor, will cool, under like exposure, to a lower temperature than will an equal amount of dry air, such as is commonly in a high barometer region, and in so doing will radiate more heat to and through the upper air and thereby correspondingly warm it, hence the cool low and warm upper atmosphere when the barometer is low and the air moist, and the reverse when the barometer is high and the air dry.

R. L. FARIS,
Secretary

THE SCIENTIFIC ASSOCIATION OF JOHNS HOPKINS UNIVERSITY

AT the meeting of the association in November an interesting lecture was given by Professor B. E. Livingston, the newly elected professor of physiological botany, under the title, "Work of the Desert Laboratory." Professor Livingston presented a brief historical outline of the conception and development of the desert laboratory idea, together with a description of the main botanical features of the country adjacent to Tucson, Ariz., and a consideration of the already excellent material facilities for research at the laboratory. A cursory account of some of the most important problems which have been attacked by the different members of the staff was given, including such topics as the theory of descent and heredity, the physiology of water storage in plants like the cacti, the physiology of parasitism, the special physiological anatomy and morphology of desert species, the physical environmental factors, the ecology of the desert, etc. The lecture was illustrated by lantern slides and photographs.

C. K. SWARTZ,
Secretary

SCIENCE

FRIDAY, DECEMBER 24, 1909

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

UNIVERSITY REGISTRATION STATISTICS

THE registration returns for November 1, 1909, of twenty-eight of the leading universities of the country will be found tabulated on page 898. Three institutions have been added to the list this year, namely, Texas, Tulane and Washington (St. Louis). The introductory comments made last year on the relative value of the figures presented in the table[1] should be borne in mind in studying the statistics herewith submitted. May I point out once again, however, that I do not wish the reader to infer that in my opinion size is the primary consideration in examining an institution of learning; on the contrary, I am thoroughly convinced that there is as much fault to be found with an overgrown department, school or university as there is with an overgrown city or potato. We are concerned in the present instance, however, with values expressed merely in student units and not in terms of productive efficiency.

This year four institutions—Iowa, Minnesota, New York University and Yale—show a loss in enrollment compared with the previous year, as against two in 1908 and five in 1907. On the whole, considerable gains have been made all along the line, the increase in several instances being quite marked. The greatest gains in terms of student units, including the summer session attendance, have been made during the year by Columbia, Chicago, Wisconsin, California, Cornell, Ohio and Pennsylvania, in the order named, each one of

[1] SCIENCE, N. S., Vol. XXVIII., December 25, 1908, p. 911.

Faculties November 1, 1909	California	Chicago	Columbia	Cornell	Harvard (incl. Radcliffe)	Illinois	Indiana	Iowa	Johns Hopkins	Kansas	Michigan	Minnesota	Missouri	Nebraska	New York	Northwestern	Ohio State	Pennsylvania	Princeton	Stanford	Syracuse	Texas	Tulane	Virginia	Washington	Western Reserve	Wisconsin	Yale
College Arts, Men	583	794	682	} 950	2256	400	508	521	158	526	1116	618	491	482	340	390	375	368	894	540	} 1810	497	91	328	79	321	744	1288
College Arts, Women	995	670	513		464	465	428	522	...	580	654	953	459	472	158	557	359	...		456		476	181		139	297	878	...
Scientific Schools*	802	.	686	1727	96	1067		201	...	432	1291	590	548	523	210	58	857	807	870	475	400	230	145	105	162		783	968
Law	112	199	318	256	760	168	131	235	378	204	760	376	249	170	768	261	180	344	..	42	189	314	64	256	94	139	149	348
Medicine	60	146	907	176	842	519	264	278	174	83	354	276	30	116	472	671	...	542	..	71	139	206	428	86	190	92	48	125
Non-Professional Grad. Schools	337	441	797	256	423	230	111	121	...	70	151	93	122	97	264	82	76	389	134	84	55	...	24	28	24	24	259	413
Agriculture	171	...	...	509	...	531	...	...	...	...	...	681	275	390	...	...	284	...	...	...	...	...	...	...	...	...	310	...
Architecture	†	...	129	140	...	240	...	...	...	...	†	...	...	...	...	...	36	191	...	...	62	...	13	...	19	...	...	...
Art	116	...	...	...	...	1	...	†	...	39	...	...	...	61	...	...	...	...	...	...	124	...	79	..	184	...	...	49
Commerce	213	...	...	...	73	133	...	†	...	...	†	...	...	...	868	300	...	487	...	...	...	...	...	...	...	...	258	...
Dentistry	57	...		...	86	107	...	155	...	...	212	196	...	...	...	306	...	434	...	...	...	...	89	...	93	67	...	...
Divinity	...	174	...	...	48	...	...	...	...	...	...	...	...	...	...	216	...	...	...	...	...	...	...	...	...	...	...	109
Forestry	†	...	...	...	†	†	...	...	...	...	†	96	...	88	...	...	28	...	...	...	...	...	...	...	...	...	...	63
Journalism	...	...	...	...	...	13	...	...	...	...	†	...	65	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Music	†		25	...	...	55	..	37	...	124	...	†	...	475	...	382	...	29	...	...	758	.	39	.	...	...	106	75
Pedagogy	†	184	974	...	...	†	...	†	...	...	†	60	220	316	441	...	46	541	...	...	80	280	27	..	...	...	...	...
Pharmacy	76		200	...	...	173	...	58	...	70	98	81	...	15	...	217	75	...	...	...	...	61	8		...	71	87	...
Veterinary Medicine	...	...	...	98	...	...	...	...	...	...	...	...	...	...	12	...	202	168	...	...	...	...	...	...	...	...	...	..
Other Courses	..	394	.	405	...	38	...	55	...	...	...	110	...	...	...	150	137	325	...	...	103	29	47		19	63	46	..
Deduct Double Registration	*20*	*198*	...	*5*	...	...	...	*94*	...	*156*	...	...	*233*	*28*	*109*	*343*	*13*	*20*	...	...	*82*	*298*	*74*	*36*	...	*11*	*108*	*144*
								2024	710	1922	4631	4086	2226	3121	3424	3129	2644	4608	1396	1604	3138	1795	1156	767	1008	1063	3496	3264
								361	...	368	1225	402	552	402	563	244	642	449	...	59	203	848	782	...	.	...	1133	12
								139	...	*146*	*597*	*137*	*189*	*121*	*144*	*176*	*274*	*200*	.	*45*	*93*	*151*	*56*	...	...	...	*383*	...
								2246	710	2144	5259	4351	2589	3402	3843	3197	3012	4857	1396	1620	3248	2492	1882	767	1008	1063	4246	3276
								2556	698	2086	5188	4807	2558	3154	3951	3113	2700	4555	1314	1541	3204	1446	1171	757		1016	3876	3466
								2188	651	1932	4953	4207	2274	2812	3648	2714	2344	4184	1311	1504	3162	1474	1219	757	...	914	3401	3435
								1930	618	1690	4674	3944	2071	2807	3283	2635	2180	3934	1352	1530	3004	1351	1285	745	...	905	3099	3477
								1700	668	1706	4521	3940	1987	2685	2912	2791	2057	3480	1361	1506	2776	1190	888	696	.	856	3083	3477
								1460	740	1446	4000	3886	1704	2728	2380	2856	1758	3027	1385	1424	2452	930	1124	691		808	2370	3006
								1260	694	1319	3926	3550	1540	2518	2177	2740	1710	2644	1434	1370	2207	785	1087	638		765	3221	2990
								...	67	257	...	140	96	350	525	81	...	...	...	...	...	142	40	...	40	62	3162	...
								160	214	137	466	239	189	250	295	351	224	483	185	150	240	129	204	96	142	231	489	401

* Includes schools of mines, engineering, chemistry and related subjects

† Included elsewhere. ‡ No figures furnished

Note.—The Texas and Tulane figures for 1908–1909 are exclusive of the summer session

these having gained over three hundred students. Columbia was the only institution to register an increase of over four hundred students this year, whereas there were no less than eight last year. Omitting the summer session, the largest gains have been made by Pennsylvania, Cornell, Wisconsin, California, Ohio and Nebraska, in the order given, the growth in each case being one of two hundred students or more. Comparing this year's grand totals with those of 1902, we find that the largest gains during this period have been made by Pennsylvania, Columbia, Cornell, Illinois, New York University, Michigan, Ohio, Wisconsin, Syracuse, Chicago and Missouri, each of these universities showing an increase of over one thousand students. It will be observed that these institutions are fairly evenly divided between the east and the west, but that the first three are all eastern institutions, although it is ordinarily supposed that, speaking broadly, the western institutions have been growing much more rapidly than the eastern institutions during the past decade and at the expense of the latter.

According to the figures for 1908, the twenty-five universities included in the table ranked as follows: Columbia, Harvard, Michigan, Chicago, Cornell, Minnesota, Pennsylvania, Illinois, New York University, Wisconsin, California, Yale, Syracuse, Nebraska, Northwestern, Ohio, Missouri, Iowa, Indiana, Kansas, Stanford, Princeton, Western Reserve, Virginia, Johns Hopkins. Comparing this with the order for 1909, we observe that Chicago and Michigan have changed places, that Pennsylvania and Illinois have passed Minnesota, that Wisconsin and California have passed New York University and that Yale and Syracuse have been passed by Nebraska. For the second time in the history of American higher institutions of learning the six thousand mark has been exceeded, Columbia having a total enrollment this year of 6,132, Harvard having registered 6,013 students in 1903. Cornell is the fifth institution to pass the five thousand mark, its total registration this year being 5,028; Harvard passed it a number of years ago, Columbia in 1907 and Chicago and Michigan last year. Omitting the summer session enrollment, the order is naturally somewhat different, namely, Columbia, Michigan, Pennsylvania, Harvard, Cornell, Illinois, Minnesota, Wisconsin, California, New York University, Yale, Syracuse, Northwestern, Nebraska, Chicago, Ohio, Missouri, Iowa, Kansas, Texas, Stanford, Indiana, Princeton, Tulane, Western Reserve, Washington, Virginia, Johns Hopkins—the order being quite different from that of last year, most notable being the change of position between Columbia and Michigan and the passing by Pennsylvania of Minnesota, Harvard and Cornell; Illinois has also passed Minnesota, while Wisconsin and California have passed New York University.

Considering the various faculties in order, we find that, with a few exceptions, notably Northwestern and Wisconsin, there have been gains all along the line in the attendance on the male undergraduate academic departments, the most important increases being shown by Princeton, Nebraska, Stanford and Kansas. The gain in the case of Princeton, however, is evidently due in great measure to a readjustment of terminology. The enrollment of undergraduate women also shows a satisfactory general increase, the gain being most marked in the case of California, Wisconsin, Radcliffe and Northwestern. At California, Illinois, Iowa, Kansas, Minnesota, Northwestern, Tulane, Washington and Wisconsin, and probably at Cornell

and Syracuse, the number of the undergraduate women is larger than that of the men. Harvard continues to lead in the number of male academic students, being followed by Yale, Princeton, Michigan, Chicago, Wisconsin, Columbia and Minnesota; including the women, the order would be Harvard, Michigan, Wisconsin, Minnesota, California, Chicago, Syracuse, Yale, Columbia, Kansas and Iowa, each of these institutions enrolling over one thousand academic students.

A general depression is noticeable in the case of the engineering schools, Stanford being the only institution to exhibit a noteworthy gain, the increase in the case of Illinois, Syracuse, Virginia and Yale being insignificant, Cornell remaining stationary, and every one of the other institutions showing a loss, which in the case of several is quite marked. At Columbia there has been a gain of ten per cent. in new students, which, however, was not large enough to offset the loss of old students occasioned primarily by increased standards for advancement. Cornell continues to maintain its lead in the number of scientific students, Michigan and Illinois being the only other institutions to attract over one thousand students to their schools of engineering; these are followed by Yale, Ohio, Pennsylvania, California, Wisconsin, Columbia, Minnesota, Missouri and Nebraska, each of these universities attracting over five hundred students to their scientific schools.

Thirteen of the medical schools and ten of the law schools exhibit a loss as against last year, while nine of the medical schools and twelve of the law schools have experienced an increase in attendance, there being a total loss of 185 students in medicine and of 79 students in law since last year at the institutions included in both this and last year's tables. The largest gains in medicine have been registered by New York University and Northwestern, in law by Harvard, Ohio and Michigan; the largest losses in the former have been experienced by Michigan and Iowa, in the latter by Minnesota and Yale. The eastern institutions show a loss of three students in medicine and of eight students in law, whereas the western institutions lost 182 in medicine and 71 in law. New York University still attracts the largest number of law students, being followed by Harvard and Michigan, Minnesota, Yale, Pennsylvania, Columbia and Texas, each of these having an enrollment of over three hundred students. In medicine Northwestern has passed Pennsylvania, these being followed by Illinois, New York University, Tulane, Johns Hopkins, Michigan, Harvard and Columbia, all of these institutions enrolling more than three hundred students.

The graduate schools experienced an increase of 393 students, Harvard being the only institution on the list to show a loss of any moment, the largest gains having been made by Northwestern, Indiana and Columbia. The last named institution, with an enrollment of 991 students (to the 797 in the table should be added 194 graduate students at Teachers College, who are omitted here for the sake of avoiding the item of double registration), has by far the largest graduate school, being followed by Chicago, Harvard, Yale, Pennsylvania, California, New York University, Wisconsin, Cornell and Illinois, each of these institutions enrolling over two hundred nonprofessional graduate students. It will be observed that six of these institutions are in the east and four in the west.

All of the schools of agriculture show a most encouraging increase, the single exception being Minnesota, where the apparent decrease of 348 is undoubtedly due to the fact that the students enrolled in the

short course were included last year but omitted this year. In spite of this fact, Minnesota remains at the head of the list so far as attendance is concerned, being followed by Illinois and Cornell, as last year.—Illinois, Pennsylvania and Cornell exhibit gains in architectural students, in the order named, while Columbia and Syracuse have remained stationary. The four largest schools are those of Illinois, Pennsylvania, Cornell and Columbia.—Northwestern, California, Pennsylvania and Harvard have registered an increase in their schools of commerce, Illinois and New York University showing a very slight loss. The last named institution and Pennsylvania maintain the largest schools.—The dental schools, which last year for the most part suffered a loss, have made encouraging advances, Iowa being the sole exception, and the decrease in her case is slight. Northwestern and Pennsylvania registered the largest gains. From the standpoint of attendance on the dental schools the universities rank in the order Pennsylvania, Northwestern, Michigan, Minnesota.—Only four of the institutions on the list, that is, only one seventh, support divinity schools, the eastern universities, Harvard and Yale, showing a gain, the western universities, Chicago and Northwestern, a loss. The latter institution has the largest attendance on this particular faculty.—The forestry students are in several instances not listed separately; wherever they are, an increase is apparent, except at Ohio, the loss there being a small one.—Nebraska, Northwestern and Syracuse attract the largest number of students of music, and are the only institutions that registered an increase in this department, Columbia's attendance having remained stationary.—Missouri, New York University and Syracuse have fewer students of pedagogy than they had last year, the Teachers College of Columbia University leading in enrollment, with Pennsylvania, New York University, Nebraska, Texas and Missouri following in the order given. The 544 students mentioned under pedagogy at the University of Pennsylvania are enrolled in courses for teachers.—Northwestern, California, Columbia and Nebraska have made gains in pharmacy, Wisconsin has remained stationary and all of the other institutions show losses in this field. Columbia continues to maintain the largest school of pharmacy and Northwestern has passed Illinois.—Ohio, Pennsylvania and Cornell attract the largest number of students of veterinary medicine and all three have made slight gains, New York University having remained to all intents and purposes stationary.

Two thirds of the institutions experienced an increase in their summer session enrollment, the most significant gains having been secured by Columbia and Chicago. The latter attracted over three thousand students to its summer quarter, Columbia drew almost two thousand to its summer session, and Harvard, Michigan, Indiana and Wisconsin all had over one thousand students. The Columbia figures are exclusive of students registered at Camp Columbia, Morris, Conn., for summer work in surveying or geodesy. In connection with the summer session it must be borne in mind that all of the summer students are not of college grade, but no detailed figures on this point are available.

The New England colleges for women have fared better than those for men and those for both sexes, Smith, Wellesley and Mt. Holyoke all showing gains over last year, whereas Dartmouth, Brown, the University of Maine, Amherst, Tufts (college only) and Bowdoin show losses, the Massachusetts Institute of Technology, Wesleyan and Williams having registered an increase

over last year. Vassar and Bryn Mawr, Lehigh and Lafayette and Oberlin (college only) also exhibit a gain in attendance, while Purdue and Haverford show a slight loss. All of the institutions just mentioned, with the exception of Brown, Bryn Mawr and the Massachusetts Institute of Technology, show an increase as compared with five years ago, the figures in detail being as follows:

Institution	1909	1908	1904
Amherst	526	528	412
Bowdoin	419	420	363
Brown	974	993	988
Bryn Mawr	412	393	441
Dartmouth	1,197	1,-33	926
Haverford	157	160	146
Lafayette	468	455	422
Lehigh	667	662	609
Massachusetts Inst. of Tech.	1,480	1,462	1,561
Mount Holyoke	752	748	674
Oberlin (college only)	953	855	652
Purdue	1,682	1,717	1,359
Smith	1,609	1,566	1,067
Tufts (college only)	428	434	375
University of Maine	850	884	563
Vassar	1,039	1,014	979
Wellesley	1,319	1,282	1,050
Wesleyan	343	322	305
Williams	528	487	443

The falling off in the number of undergraduates at Brown may be attributed to increased entrance requirements demanded of candidates for engineering degrees. Of the 1,197 students enrolled at Darmouth, 1,112 are in the college, 57 in the medical school, 50 in the Thayer school and 35 in the Tuck school. At Oberlin the total registration, including in addition to the college the theological seminary, the conservatory of music, the academy and the students in drawing and painting, is 1,798, as against 1,748 in 1908 and 1,505 in 1904. The Purdue figures represent the total registration in the four classes in the schools of agriculture, chemical engineering, civil engineering, electrical engineering, mechanical engineering and science, the two classes in the school of pharmacy, together with special and graduate students in the university as a whole; no entry is made for the agricultural winter course, since this does not open until January. At Tufts the medical and dental schools show an attendance of 717, a gain of 36 over last year and of 108 over 1904, the total attendance for the three years in question being 1,145, 1,115 and 1,004, respectively. The slight decrease in enrollment at the University of Maine is probably due to increased standards of admission and to the increase in tuition for students who come from outside the state of Maine. At Vassar an effort is made to keep the total number down to approximately a thousand. The excess this year is owing to the fact that an unusually large number of former students returned in September, while the falling off among the new students was smaller than usual during the summer. At Wesleyan the chief gain has been experienced in the freshman class, which is the largest in the history of the college. There has been a total gain of 21 students, in spite of the fact that a considerable number of the women students left this year by reason of the recent action of the trustees abolishing coeducation; there are at present only 19 women students enrolled.

Taking up the various institutions in alphabetical order, we find that the *University of California* shows gains in every department with the exception of engineering, the most substantial increase being found in the number of undergraduate women, namely, one of 116 students. Of the 337 students in the graduate school about 160 are women, most of whom are candidates for the teacher's recommendation. The graduate school also includes 14 candidates for the degree of *juris doctor*, which is conferred two years after the A.B. or the LL.B.

The *University of Chicago* shows a substantial gain in its grand total, the chief increase having taken place in the summer quarter. In the present quarter the largest gains have been made in the courses given for teachers, listed under "other courses," and in the male college department. The graduate school also shows a healthy gain, while divinity, law and medicine experienced slight losses, pedagogy having remained stationary and the registration under "college of arts, women," having fallen off from 685 to 670.

Columbia University shows a large increase in its grand total and a gain of 110 students in its fall enrollment, gains in the number of academic undergraduates, in the graduate schools and at Teachers College more than offsetting slight losses elsewhere. The attendance on the schools of law and medicine has remained stationary. The summer session experienced the encouraging increase of 436 students.

Cornell University shows a healthy increase both in the fall enrollment and the summer session, the increase in the grand total being one of 328 students. The medical school alone shows a loss in attendance, the scientific schools having remained stationary. Of the 1,727 students in the latter department, 1,167 are registered in mechanical and 560 in civil engineering. Of the medical students 160 are in New York and 18 in Ithaca. The students listed under "other courses" are enrolled in the short winter course in agriculture, there being a total gain of 162 students in this and the regular agricultural course.

Harvard University also experienced an increase in its summer as well as its fall registration, the only losses in attendance occurring in the scientific schools, the graduate school and the medical school. Of the 96 scientific students, 83 are registered in the graduate school of applied science and the remainder in the Lawrence scientific school. The Lowell Institute, in cooperation with Harvard University, offers free courses of lectures corresponding closely in subject matter, methods of instruction, examinations and scale of marking, with those given in Harvard College. These courses, when accepted by the appropriate departments of the faculty of arts and sciences, may be counted towards a degree by men who afterwards secure admission to Harvard College. Nine hundred and twenty persons are now registered in these courses. About five of this number are now registered in Harvard University. The opportunities offered by these courses of lectures now make it unnecessary for the university to maintain the afternoon and Saturday courses for teachers, which it has been accustomed to offer in the last two years.

The *University of Illinois* gained 121 students this fall, but lost 25 in the summer. The chief increase this fall is to be found in the schools of agriculture and architecture and in the number of undergraduate women. Losses have been experienced in music and pharmacy, the other faculties having remained practically stationary. The marked increase in the number of agricultural students is said to be the natural result of the growing appreciation of the value of scientific knowledge on the part of the farmers. It is difficult to predict whether the increase in architecture is sporadic or likely to be permanent. The losses in music and in pharmacy are due to increased requirements.

Indiana University registered an increase of 134 in its summer session and one of 50 in the fall enrollment, losses in medical and male college students being more than offset by gains in the other faculties, an increase of 71 students in the graduate school being especially noteworthy. The

last mentioned gain, however, is in all probability due to a change in classification and does not represent an actual growth of that size in graduate students.

The *State University of Iowa,* which last year exhibited an increase in every department but dentistry, has lost 98 students this fall, the summer session having remained stationary. The chief losses have been experienced in medicine, music and engineering. The 55 students listed under "other courses" are registered in the nurses' training school. The most noticeable change in enrollment is the loss in numbers in the college of medicine. This is due to an advance in the requirement for admission from the completion of four years of high school work to the completion of one year of college work. In 1910 the requirement for admission to the college of medicine will be two years of college work. The requirement for admission to the college of dentistry was advanced from the completion of three years of high school work to the completion of four years of high school work. The loss on this account, however, was slight.

Johns Hopkins University has gained 12 students since last year, an increase of 23 students in medicine being diminished by a loss of 8 college and 3 graduate students. Forty-five students are enrolled in the special courses for physicians and 67 in the college courses for teachers given afternoons and Saturday mornings.

The *University of Kansas* lost a few students in the summer, but gained 56 this fall, the gain in the grand total being one of 58, there being a decrease in the number of summer session students who returned for work this fall. There is a large gain in the attendance of male academic students, while the engineering schools have not increased in numbers. The most marked increase in attendance is found in the graduate school. In spite of the fact that two years of college are now required for admission to the medical school, the first-year class shows a healthy increase in attendance.

The gain of 71 students in the grand total attendance of the *University of Michigan* is to be laid at the door of its summer session, which showed an increase of 139 students, as against a loss of 5 in the fall enrollment, gains in male undergraduates, law and dentistry not quite offsetting losses in medicine, engineering, pharmacy and the graduate school. Mr. Arthur G. Hall, registrar, writes as follows:

Including the graduate students registered in the summer session, but making due allowance for duplications, there were altogether 270 graduate students registered prior to November 1. The figures given for law are exclusive of 35 students and those for medicine of 37 students registered in the "combined course." The department of law has a larger number of students than ever before. As was foreseen, the raising of the requirements for admission to the department of medicine and surgery to two full years of the arts course, has resulted in a falling off in the size of the entering class. The combined arts-medical and arts-law courses continue to grow in favor, as does the course in forestry. The dental college is fully settled in its new building. In spite of the higher admission requirements which went into effect this year, this college shows a ten per-cent. increase in enrollment. The summer session of 1909 was more largely attended than the session of any previous year, the total registration being 1,225. This was a gain of 148 over the session of 1908, or an increase of fourteen per cent.

Mr. E. B. Pierce, registrar, has furnished the following report for the *University of Minnesota:*

The only decrease in attendance that is of any importance is in the college of medicine and surgery and in the college of law. The decrease in the college of law is due to the increased entrance requirement. All students entering that department now are required to complete one full year of work in the college of arts, and in 1911 two full years in the college of arts will be re-

quired for admission. Last year the total registration in law was 614. This year it is 376. The increase of 131 in the freshman class of the college arts is undoubtedly directly related to this increase in the entrance requirements for admission to law.

In 1908-9 the registration in the college of medicine and surgery was considerably increased by the amalgamation of the Hamline University medical department with that of the University of Minnesota, reaching 253. This year the registration has fallen to 176, due partly to the graduation of a number of the transferred Hamline students, and partly to the fact that the number who would naturally enter the freshman class of the Hamline medical department direct from the high school would be required to complete two years of college work in arts before gaining admission to the freshman medical class here.

The college of engineering shows a decrease in registration of 75, probably due to the lengthening of the course from four to five years. There are 612 students enrolled in the school of agriculture at the present time. While this school is not doing work of college grade, it is, on the other hand, not in any sense a preparatory school, but offers a three-year technical course. The registration figures for the short courses in agriculture, such as the teachers' summer school, the summer forestry school, the farmers' short course and the dairy school, amounting last year to 485, can not be given at this time.

The registration at the *University of Missouri* shows a slight increase over last year, but the gain is due almost entirely to the summer session. The fact that the regular session fails to maintain the rate of increase of preceding sessions is due to a number of causes. Chief among these is the establishment of tuition fees in the schools of law, medicine, engineering and journalism and for non-residents in all departments. The registration in individual departments has also been affected by regulations adopted for the reduction of double registration which has been reduced one half, and will be still further reduced during next session. As noted, last year the registration in the school of medicine was affected by uncertainty regarding plans for removing the last two years of the course to St. Louis or Kansas City. It was finally decided to discontinue temporarily the work of these years. The decrease in the school of education is only an apparent one, being due to the fact that beginning with this session two years of college work are required for admission to this school. The college of agriculture continues to show the largest increase in registration.

The *University of Nebraska* shows a gain of 200 in the fall enrollment and of 54 in the summer session. There has been a large increase (193) in the male academic department, apparently at the expense of the scientific schools (— 107), but this is due to the fact that the "general scientific" students are now included under arts, whereas they were formerly registered in the industrial college. The college of arts and sciences will hereafter grant the degree of bachelor of science, as well as that of bachelor of arts. There is a loss in the number of undergraduate women, probably due to transfers to the teachers college. The number of entrance points has been increased from 28 to 30, the new regulation to become operative on September 1, 1910.

New York University has a loss of 63 in the summer and of 33 in the fall enrollment. The chief losses in the present term are found in the schools of law, education and engineering, which gains in medicine and male undergraduates were not quite able to overcome.

Owing to the large first item of double registration, it is difficult to draw accurate conclusions concerning the changes in attendance on the different faculties of *Northwestern University*. The school of divinity and the male college department seem to be the only faculties to have suffered a loss, entries being made for the first time under the engineering school and

the graduate school. The total fall enrollment shows a gain of 137 students, the summer session a loss of 13 students. The students entered under "other courses" are registered in the department of oratory.

Ohio State University has had an encouraging increase both in this fall's and in last summer's enrollment, the gain being one of 202 and 139 students, respectively. The only faculties to suffer a loss are those of engineering, forestry and pharmacy, which in the case of the two departments last mentioned is only slight. Miss Edith D. Cockins, registrar, reports as follows:

The shortage in the engineering college is in the freshman class: an enrollment of 262 as against 301 the same date last year. The enrollment in the pharmacy college is 2 less than it was a year ago. In the college of arts there is an increase of 90; in agriculture an increase of 75; in law an increase of 75; in education an increase of 18; in veterinary medicine an increase of 15.

Mr. Edward Robins, assistant secretary of the *University of Pennsylvania*, has submitted the following report:

A comparison with previous figures shows that this is the largest registration in the history of the University of Pennsylvania, a distinct gain in the college, graduate school, law school, school of dentistry and school of veterinary medicine being noticeable. There is some falling off in the medical registration, but this was to have been expected. The requirements for admission to this school have been increased, and for the academic year 1909–10 candidates for admission into the school of medicine must have successfully completed work equivalent to that prescribed for the freshman class in colleges recognized by our university—this to include a knowledge of physics, chemistry and general biology or zoology, and together with appropriate laboratory work in each of these subjects, as specified by the College Entrance Examination Board, and two foreign languages, one of which must be French or German. Next year, 1910–11, candidates must have successfully completed work equivalent to that prescribed for the freshman and sophomore classes. The slight falling off in the medical registration therefore is a healthful sign, rather than one of weakness.

Princeton University shows an increase of 84 students, although the present enrollment is smaller than that of 1903. The graduate school has increased by 43 students, while changes in the distribution of academic and scientific students render comparisons in those departments impossible.

Mr. O. L. Elliott, registrar, reports as follows for *Stanford University:*

There are no general changes worthy of note in regard to the descriptive matter which you have specified. Our enrollment was depressed last year by the student upheaval of the previous year. This we have recovered the present year. The university is making no effort to increase the total attendance. In many ways we are still marking time and are uncertain as to the direction of the future development of the university.

The most important event during the last year was the establishment of a medical department. Only the first year of the course is given during 1909–10. The class beginning this year will be carried through, the second year being added in 1910–11, and so on. The first year's class numbers 13.

The 42 students in the law school are exclusive of 29 college seniors taking first year law.

Syracuse University reports as follows:

The apparent loss in the college of liberal arts is largely due to the fact that one course heretofore included in that college has been taken out and is counted elsewhere. We think the fact that our entrance requirement is 75 per cent., as against 65 per cent. upon the part of many of the other colleges and upon the part of the requirement of the regents, has been militating somewhat against our attendance this year in the college of liberal arts. The loss in the college of medicine is due to the increased requirements—one year of college work. In 1910 two years of college work will be required for entrance.

The figures of the teachers college hardly give a fair impression of the work of that college. Three hundred and sixty-five students of the college of liberal arts are taking regular pedagogical work in the teachers college, but are not counted in the registration of that college. The college will hereafter be known as the Margaret Olivia Slocum Teachers College.

The courses in music and art show heavy gains, as does the registration under "other courses" (belles lettres, school of library, economy, etc.). The fall enrollment exhibits an increase of 54 students.

E. J. Mathews, secretary to the president, has submitted the following report for the *University of Texas:*

The total attendance is larger this session than ever before in the face of advanced entrance requirements in every department. The attendance on the law department is lower than heretofore on account of the going into effect this session of the requirement of five college courses. It is very probable that by another year the registration figures will be as large as ever. The attendance on the department of engineering is less than formerly, probably due to the fact that the only other school of engineering in the state has lowered its admission requirements.

The 47 students mentioned under "other courses" at *Tulane University* are taking work in domestic science.

Howard Winston, registrar, reports as follows for the *University of Virginia:*

The enrollment this fall slightly exceeds that of 1908. The increase has been in the college and engineering departments, notwithstanding the fact that two more units are required for entrance. Three years' residence are now required for graduation from the law school, instead of the two previously demanded, while a year of college work is now required for admission to the medical school, these changes causing a falling off in attendance on both faculties.

Western Reserve University shows a gain of 67 students over last year, an increase in undergraduate women, in the graduate school, the library school (other courses) and in dentistry more than offsetting slight losses in the undergraduate men, law, medicine and pharmacy. Leaving the graduate and library schools out of consideration, there is a gain of 35 new students over 1908.

The *University of Wisconsin* shows an increase in the fall total of 258 and in the summer session of 106. The students of commerce are for the first time listed separately, as are the students of home economics included under "other courses." There is a gain of 99 students of agriculture and of 85 undergraduate women. Medicine has experienced a gain of 18 and the graduate school one of 43 students. Mr. W. D. Hiestand, registrar, submitted the following comment:

Our total number of graduate students is 259. The 54 apportioned to professional schools includes graduate students taking work in engineering and agriculture. The number indicated as double registration are students taking work in two colleges; it is, therefore, impossible to eliminate this number and still do justice to the colleges concerned. The students represented in the school of music (108) are catalogued on a somewhat different basis from those of last year (216). In the reorganization of the school, the academic department has been discontinued and all candidates are now required to offer full college entrance requirements for admission, irrespective of their musical abilities. The figures will show a falling off in the college of engineering as compared with last year and also a slight decrease in the school of law.

Yale University exhibits a loss of 184 students in its fall enrollment, a considerable number of whom are law students. The academic department and medicine and music show smaller losses. The chief gains are in the graduate school and in forestry. To the scientific school registration should be added 170 graduate students included in the graduate school figures.

RUDOLF TOMBO, JR.
COLUMBIA UNIVERSITY

THE PHYSICAL LABORATORY OF THE NATIONAL ELECTRIC LAMP ASSOCIATION

A RESEARCH laboratory is now usually considered as a necessary adjunct to a large progressive, manufacturing organization. There are to-day many such research laboratories in operation in this country, employing men of scientific training and offering every facility for scientific investigation. The majority of these laboratories are engaged in chemical research, although in quite recent years the

importance and value of physical research have also been recognized, and some few physical laboratories have been established.

But although the establishment of a research laboratory by a large manufacturing organization is no longer novel, the inception, by such an organization, of a laboratory which has for its object the development of science rather than the improvement of some industrial commodity is probably without precedent. It, therefore, seemed to the writer that perhaps a brief description of the new physical laboratory of the National Electric Lamp Association, even though it is still only in the formative stage, might be of interest to the readers of SCIENCE. The object of this laboratory is scientific, the specific purpose being the development of those branches of science with which the art of lighting is closely associated. The fundamental idea which has prevailed in the organization of the work is the proper coordination of physics and physiology, the proper cooperation of the physicist, the physiologist and perhaps the psychologist.

The organization of the laboratory is proceeding with this idea as the foundation. The development contemplates no sharp distinctions among the different divisions of the work. The problems to be investigated, however, group themselves roughly into three classes, and therefore require, in order to insure the proper attention to each, a threefold division in the organization. The three groups of problems to be investigated may be classified as: (1) those that have to do with the production of luminous energy; (2) those that have to do with the utilization of luminous energy, and (3) those that have to do with the effects of luminous and attendant radiation.

Under the first class will come the investigation of the laws of radiation, and of the radiating properties of matter. The problems in this class are purely physical and the corresponding division will be entrusted to a competent physicist.

Under the third class will come the investigation of the effects of light and the attendant radiations on the eye, on the skin and on microscopic organisms. The problems in this class are physiological, and the corresponding division is under the charge of a trained experimental physiologist.

Intermediate between these two classes of problems (the first and the third) which are distinctly different, there is another (the second) which forms the connecting link. Touching on one side the physical production of light, and on the other the physiological effects of light, this intermediate division of the work will embrace most of the scientific problems peculiar to illuminating engineering. Investigations of the absorbing, reflecting and diffusing properties of matter, the measurement of light, *i. e.*, photometry, and the study of the complex phenomena of color and color sensation, properly come within the scope of this department of the work.

The present personnel of the laboratory, in addition to the director and the necessary auxiliary mechanical and clerical assistants, is as follows:

Mr. F. E. Cady, B.S., Massachusetts Institute of Technology, 1901; scientific assistant to the director. Mr. Cady was formerly assistant physicist in the Bureau of Standards, Washington.

Dr. Herbert E. Ives, B.S., University of Pennsylvania, 1905; Ph.D., Johns Hopkins University, 1908; physicist in charge of division II. of the work as outlined above. Dr. Ives was formerly assistant physicist in the Bureau of Standards, Washington.

Dr. Percy W. Cobb, B.S., Case School of Applied Science, 1894; M.D., Western Reserve University, 1902; physiologist in charge of division III. of the work. Dr. Cobb was formerly assistant in the physiological research laboratory and lecturer on the special senses at the Western Reserve University.

It is the intention to secure another physicist to assume charge of division I., and in addition several assistants, as soon as the development of the work justifies it.

The laboratory at present is established in a small one-story and basement brick building originally occupied as office and laboratory by Mr. Charles F. Brush. Adequate equipment

is being provided, and there are already available a complete instrument shop and a good working library, the two necessary adjuncts to scientific research.

Edward P. Hyde,
Director

Cleveland, Ohio

THE AMERICAN BREEDERS' ASSOCIATION

The American Breeders' Association was organized in response to a long-felt need and to satisfy a desire among breeders of animals and plants for a central agency through which these interests might mork effectively in furthering their common welfare.

The objects of this organization are chiefly three: (1) to determine the laws of inheritance in animals and plants; (2) to learn the application of these laws to increasing the intrinsic, commercial and artistic values of living things; (3) to aid in bringing about this desired improvement through associated effort.

Much has already been achieved by breeders. The magnificent herds and studs scattered over North America are sufficient evidence that our animal breeders have not been idle and that they have builded wisely. The achievements of the breeders of field crops and horticultural plants have provided our modern journals and the daily press with material eagerly sought by a public which appreciates the wizard-like creations of these workers in plastic living forms. The productions of our florists and nurserymen brought forth in response to a popular demand for the artistic and novel, to the student of heredity, are monuments to the skill of the breeder and indicate the stupendous possibilities of similar work with our great economic animals and crops.

Great as have been the achievements of breeders, no definite science of breeding has been built up. Much investigation into the theory of heredity has been made and volumes of theoretical and experimental data have been accumulated through the efforts of the scientific workers. The plant breeders as a whole have their work in more scientific form than have the animal breeders. They are only on the threshold, however, of the science of breeding. Those who have attained success in breeding have often happened upon a valuable strain or method and exploited it with good results. Many who have met with success have only a very imperfect system. Some use artistic sense, or intuition, and judgment only. Others use statistical methods almost entirely. Whatever the practise of any successful animal or plant breeder may be, he can rarely advise his neighbor as to how to proceed and assure him of success. Each has been compelled to learn by costly experience and work in the hope that he may by chance hit upon a profitable method.

It was to bring order out of this chaos of theory and practise that the American Breeders' Association was created. The first step was to organize a large central association with a low membership fee which would place it within the reach of all of these thousands of modest unheard of workers in plants and animals whose collective experience must furnish much of the data upon which to build a practical science of breeding. By means of its annual and other meetings, this association is designed to become a great school and clearing house to which will be brought the latest and best thought in breeding from these many sources, and from which a balance will finally be struck upon which to base intelligent and practical work.

The need of a national association was first felt by those who were closely in touch with breeding work and had broadly observed the field. It has been found that the methods necessary to success in breeding make it expensive. Its pursuit is often beyond the means of the average producer, because large numbers of individuals must be available with which to work and great amounts of time and care are required in handling and recording each breeding unit. The breeding of many of the commercial field crops is beyond the means of private enterprise. The breeding of animals is many times more expensive than the breeding of plants. To be most effective, large plans and cooperative effort is necessary.

The field occupied by the American Breed-

ers' Association is, therefore, unique and of the highest economic importance. The United States produces annually about $5,000,000,000 worth of animals and crops which may be improved by careful breeding. A conservative figure, based upon the experience of those who have actually improved specific crops and breeds, justifies an estimate of 10 per cent. increase in this total by breeding alone. The cost of this improvement need not be more than 10 per cent. of the increase or one per cent. of the whole. Thus, $500,000,000 annually may be added to the wealth of the nation by breeding, representing a profit of $450,000,000.

Under a wise system of patent laws, invention and manufacture have been stimulated to produce and bring into wide use highly efficient forms of machinery which have greatly increased the efficiency of the agricultural producer. Through the further impulse given to better tillage and better farm management by state boards of agriculture, state experiment stations and the United States Department of Agriculture production has been greatly increased. The possible increase in the value of our plant and animal products through breeding alone is nearly as great as that now being realized through all these agencies. It is this task to which the American Breeders' Association is directing its efforts.

This work must be done by and through the practical animal and plant breeders with the aid of the scientific investigators and in cooperation with public agencies. Results can not be expected immediately, as much preliminary work must be done and years of effort will be required before permanent results can be expected in any line. Improved breeds and varieties can not be protected by patents and their further improvement thus stimulated and the breeder assured rewards for his skill and effort. In the nature of things improved strains soon become common property. The state and the national governments, therefore, should and will aid in placing this work on a substantial footing as soon as feasible plans are formulated and given adequate support.

The American Breeders' Association is at present attacking the first two of the problems before it, viz., the study of the little understood laws of heredity in living things, and the determination of such practical methods as can be applied in the actual improvement of plant and animal forms. This work is being centered in committees of from three to seven members, who are leaders along the lines for which they are chosen. Such problems as the business side of animal breeding, breeding meat-producing animals, the business side of plant breeding, breeding sugar crops, fiber crops, forage crops, cereal crops; breeding swine, breeding carriage horses, running horses, trotting horses, draft horses; breeding insects and bees, breeding fruits, breeding ornamental plants; breeding for the dairy, breeding general purpose cattle; the scientific investigation of the theory of heredity are taken up by the committees adapted to each subject. These committees report to the association at its annual and other meetings on the progress of their work and will make such recommendations to the society as they find wise and expedient. In this way the energies of the association will be centered upon the specific problems before it, while each committee has the resources of the entire membership to aid in its work.

The American Breeders' Association built up a membership of about one thousand, one hundred of whom are life members. This membership includes the foremost animal and plant breeders and scientists of this continent and many abroad. It has published five annual reports, a neatly-bound 400-page volume, containing the papers and addresses presented at the annual meeting and the records of the meeting.

W. M. Hays,
Secretary

Washington, D. C.

THE INTERNATIONAL CONGRESS ON THE EDUCATION OF CHILDREN AT HOME

The Third International Congress will be held under the patronage of the Belgian government, in connection with Universal Exposition at Brussels in August, 1910.

The idea of bringing together competent persons to discuss the subject of home (or family) education in its various bearings, and to formulate methods for promoting the physical, intellectual and moral well-being of children, originated in Belgium, and the First International Congress with this object in view met at Liège in 1905.

Interest in the movement, meanwhile, became wide-spread among educational authorities in the different states of Europe, while its importance as a possible means of diminishing criminal tendencies and so preventing crime and other anti-social evils was recognized by the various governments. This growing interest was manifested in the Second International Congress, convened at Milan in 1906 under the patronage of the Italian government.

The Third Congress, which is now announced, will extend and define the work already so auspiciously begun. The character and scope of the movement in its present stage of development will be, perhaps, best understood by referring to the program issued by the organizing committee of the congress, which has been prepared in the light of the experience gained in the former meetings.

The congress will consist of five sections:

Section 1—The study of childhood.

Section 2—The education of children: (*a*) general questions; (*b*) the education of children by their parents in the home; (*c*) cooperation of the family with the school; (*d*) education in the home after school.

Section 3—Abnormal children.

Section 4—Various subjects relating to childhood.

Section 5—Documentation.

An American committee has been appointed at the request of the Belgian government by Hon. E. E. Brown, United States Commissioner of Education, to stimulate interest in the work of the congress. This committee has organized a number of subcommittees, each representing one of the sections of the congress. An effort will be made to secure a large American representation in the sessions at Brussels.

Membership in the congress entitles to a copy of the Proceedings. The membership fee is two dollars, and may be sent either to the general secretary, 44 due Rubens, Brussels, or to the secretary of the American committee.

Administrations, educational bodies and philanthropic societies can take part in the congress and be represented by a delegate. A subscription must be paid for each delegate.

Those who subscribe not less than ten dollars become honorary members. Subscriptions of this type are needed to defray the general expenses of the propaganda.

Papers and discussions may be presented in any of the following languages: French, German, English, Dutch, Italian and Spanish.

Americans wishing to participate in the discussions of the congress, or to further its work by becoming members, should communicate with the secretary of the American committee, Professor W. C. Bagley, Urbana, Ill.

THE MINING EXPERIMENT STATION AT THE UNIVERSITY OF NORTH DAKOTA

In order to promote the development of the mining and allied manufacturing interests of the state and especially to aid the utilization of the great deposits of lignite coal and the valuable clays, a Mining Experiment Station has been created as a part of the School of Mines at the University of North Dakota and a branch Mining Experiment Sub-station established at Hebron, North Dakota.

The work of these two stations will be carried on jointly. Certain lines of investigation which require much laboratory equipment and research will be taken up at the School of Mines. When conclusions have been reached here through experimental work in the laboratory, these conclusions will at once be put to a practical working trial at the testing-out plant of the sub-station. In other words, a large part of the work of the sub-station will be for the purpose of proving in a practical way and on a commercial basis, the conclusions reached in the laboratories.

In order to provide adequate facilities for carrying on these investigations at the university, as well as to provide room for the

rapidly increasing number of students taking mining engineering work, it has been necessary to add two wings to the School of Mines building and to employ additional assistance. Certain laboratories will be set aside for the experimental and research work on gas, coal, clays, building materials, cements, etc., and for this work the laboratories will be among the very best equipped in America. This work is unquestionably of very great importance to the state.

The research which has already been carried on in the Mining Engineering College of the State University relative to lignite, coal, gas and clays has attracted the attention of many men throughout the country who are interested in these subjects. It is intended to build up laboratories and carry on investigations which will be a help to the state.

The work which will be taken up most vigorously during the coming year will be for the purpose of obtaining by investigations and practical tests, a cheap and commercially satisfactory method of lignite coal briquetting, to show the best methods of burning lignite, and to determine the possibility of utilizing lignite for producing gas for light, heat and power. Considerable attention will be given also to the utilization of the high grade clays of the state for the manufacture of a variety of wares.

In order to carry on this work on a practical commercial basis, considerable machinery of special design will be installed at the sub-station at Hebron. For several months work has been devoted to machinery and methods which seemed to be suited to the manufacture of briquettes from lignite. As a result complete briquetting plant has been designed and is now being built. The press will have a capacity of 2 tons of briquettes per hour. In addition to this a specially constructed gas plant is being made for the purpose of manufacturing gas for light, heat and power from lignite coal. This will be one of the most perfect types of gas plants and large enough to produce several thousand cubic feet per day. Machinery and kilns of commercial working size will be installed later for practical testing of the higher grade clays.

THE ELIZABETH THOMPSON SCIENCE FUND

In January, 1910, there will be a meeting of the trustees of the Elizabeth Thompson Science Fund for the award of grants. Applications, in order to be considered at that time, should reach the secretary, Dr. C. S. Minot, Harvard Medical School, Boston, before January 15, 1910. All applications *must be accompanied by full information,* especially in regard to the following points:

1. Precise amount required.
2. Exact nature of the investigation proposed.
3. Conditions under which the research is to be prosecuted.
4. Manner in which the appropriation asked for is to be expended.

The trustees are disinclined, for the present, to make any grant to meet ordinary expenses of living or to purchase instruments such as are found commonly in laboratories. Decided preference will be given to applications for small amounts, and grants exceeding $300 will be made only under very exceptional circumstances. Preference will be given to those investigations which can not otherwise be provided for.

THE BOSTON MEETING OF THE AMERICAN ASSOCIATION

The hotel headquarters for physicists at the Boston meeting of the American Association for the Advancement of Science and the American Physical Society will be the Hotel Brunswick, Boylston Street, near Copley Square, which is also the general association headquarters. Rates: single rooms, $1.50 to $2.50; double, $2.50 to $3.50; with bath, single, $2.50 to $3.50; double, $3 to $4.

Section B has a joint session with Section A on Tuesday afternoon, December 28, immediately after the address of Vice-president Guthe. Interesting papers will be presented by Professors G. Runge, A. A. Michelson, E. W. Brown and H. F. Reid.

Friday morning, December 31, there will be

a joint session of Section B and Section L, the former furnishing the program. Speakers will be Professors E. H. Hall, A. G. Webster, J. F. Woodhull, C. R. Mann and probably Presidents E. F. Nichols and N. H. Black.

The Engineering Section (D) of the American Association for the Advancement of Science will hold its meetings in Room 31, Engineering Building A, Trinity Place, Boston, on December 29 and 30. Professor G. F. Swain, retiring chairman of the section and vice-president of the association, will deliver his address at 2:30 P.M. on Wednesday, December 29, subject, "The Profession of Engineering and its relation to the American Association for the Advancement of Science." Other papers have been definitely promised as follows:

Professor A. L. Rotch: "The Relation of Wind to Aeronautics."

O. Chanute: "The Present Status of Aerial Navigation."

S. P. Ferguson: "Wind Pressure and Velocity."

A. J. Henry: "Shifting of Wind with Altitude."

A. M. Herring: "Aerodynamics."

Albert Zahm, Alexander Graham Bell and others will probably contribute papers or discussions on aeronautical subjects.

C. J. H. Woodbury: "The Development of the Modern Textile Mill."

J. F. Kelly: "Music Roll Cutters."

H. E. Wetherill: "Parallel Rules."

E. H. Berry: "The Photographic Lens as an Engineering Implement."

Other interesting papers, for which titles can not yet be announced, will be on the program. The dates and hour of presentation of each paper will be announced in the Official Program of the Association which will be obtainable at the office of the Permanent Secretary, Technology Union, Trinity Place, on Monday, December 27.

SCIENTIFIC NOTES AND NEWS

MR. WILLIAM H. HOLMES, chief of the Bureau of American Ethnology, will on January 1 sever his official connection with the bureau and resume his place as head curator of anthropology in the U. S. National Museum, and in this connection will also become curator of the National Gallery of Art. Mr. F. W. Hodge will take charge of the Bureau of American Ethnology with the title ethnologist in charge.

IT is proposed to add to the collection of portraits of deceased members of the American Philosophical Society that of Professor Simon Newcomb. The formal presentation of the portrait is expected to take place in connection with the annual meeting in April, 1910. The committee in charge is: C. L. Doolittle, chairman, E. C. Pickering, Ernest W. Brown, Ira Remsen and Charles D. Walcott.

DR. THEODORE W. RICHARDS, professor of chemistry at Harvard University, has been elected a corresponding member of the Paris Academy of Sciences.

DR. ALBRECHT PENCK, professor of geography at Berlin, has been elected a corresponding member of the Munich Academy of Sciences.

DR. W. WALDEYER, professor of anatomy at Berlin, has been elected an honorary member of the Anthropological Society of that city.

PROFESSOR A. C. SEWARD, F.R.S., professor of botany in the University of Cambridge, has been elected president of the Yorkshire Naturalists' Union.

THE Walsingham medal for 1909 has been awarded by Cambridge University to Mr. L. J. Wills, for his essay entitled "The Fossiliferous Lower Keuper Rocks of Worcestershire," and a second medal to Mr. H. H. Thomas, for his essay entitled "The Leaves of Calamites (Calamocladus section), with special reference to the conditions under which they grew."

THE La Caze prize (10,000 francs) of the Paris Academy of Sciences has been given to Dr. Delezenne, of the Pasteur Institute, for his collective works.

MR. THEODORE D. URBAHNS, of the Bureau of Entomology, has been employed as assistant in research field work by the division of en-

tomology of the University of Minnesota Experiment Station.

Mr. E. J. McCaustland, professor of municipal engineering, University of Washington, has been appointed sanitary engineer to the State Board of Health.

Dr. Ejnar Hertzsprung, associate professor at Göttingen, has been elected observer in the Astrophysical Observatory at Potsdam.

It is proposed that a grant of £100 be made from the Worts Fund, Cambridge University, to Mr. J. Romanes, towards defraying the expense of a journey to Costa Rica with the object of studying the geology and geography of that country.

Dr. Charles Peabody, of Harvard University, recently made an archeological reconnaissance trip in Texas. The archeology of the mountainous region of the state, for some three hundred miles, was studied, and a fair collection of the stone implements secured for the Peabody Museum. The pictographs of the area were also investigated. During the summer, Dr. Peabody represented the museum at the Congrès Préhistorique at Beauvais, France, presenting a paper covering the results of his investigations in Texas.

Mr. W. Dawson Johnston, librarian of Columbia University, is preparing for the United States Bureau of Education a report on special collections in libraries in the United States. It is planned to make the publication a record of all collections in public libraries which are of extraordinary value, either because of their completeness or because of the rarity of their contents. In order to collect the material for this report the Bureau of Education is sending circulars to all libraries which are thought to possess such collections.

A course of lectures upon Abnormal Psychology will be given by Dr. Morton Prince, of Boston, at the University of California, from January to April, 1910.

The Friday evening meetings of the Royal Institution, London, will commence on January 21, when Sir James Dewar will give a lecture on light reactions at low temperatures. Succeeding lectures will probably be given by the Rev. Canon Beeching, Professor W. Bateson, Mr. C. E. S. Phillips, Professor H. H. Turner, Lord Rayleigh, Dr. C. Chree, Dr. H. Brereton Baker and Sir J. J. Thomson.

On December 15 the name of Cyrus Hall McCormick was installed in the Illinois Farmers' Hall of Fame at the University of Illinois. A portrait of Mr. McCormick was unveiled by his granddaughter, Miss Muriel McCormick. Among the speakers were Governor Charles Deneen, President E. J. James and Mr. Cyrus Hall McCormick, the son of the inventor. The next name to be enrolled in this Hall of Fame is that of Jonathan B. Turner, the originator and promoter of the idea of a National Land Grant for agricultural colleges in the states.

Professor Hilary Bauerman, formerly of the Royal Artillery College, Woolwich, well known as a metallurgist and geologist, died on December 5, at the age of seventy-six years.

It is announced that the council of the University of Paris has passed a resolution to the effect that monuments intended to commemorate men who have brought distinction on the University of Paris since 1808 shall be erected in the church of the Sorbonne.

The New York State Science Teachers Association will hold its fourteenth annual meeting at Syracuse, N. Y., on December 27, 28 and 29, in conjunction with the Associated Academic Principals and other educational bodies. The president of the association is Professor W. M. Smallwood, of Syracuse University.

The week of December 6–11 was appointed by the International Commission for Scientific Aeronautics for the long series of observations in the upper air. The United States Weather Bureau was unable to make the ascensions of sounding balloons promised at Omaha, but three of these balloons were sent up by Professor A. L. Rotch, from Pittsfield, Mass., and two pilot balloons, for wind direction and velocity, from Blue Hill Observatory.

One of the sounding balloons, with good records of pressure and temperature, has already been recovered.

WE learn from the London *Times* that the British Natural History Museum will shortly be enriched by Lord Walsingham's gift of his unrivaled collection of Micro-Lepidoptera. which will be transferred from Merton Hall to Cromwell-road in the spring of the coming year. The collection which thus passes into the possession of the nation is by far the richest of the kind in the world. When examined by the museum specialist in 1901 it was officially reported to the trustees to contain over 200,000 specimens, in a condition of preservation which left nothing to be desired, and to include about nine tenths of the recorded species, besides a large quantity of unworked material. Since that date it has continually been added to, until now the number of specimens is about 260,000. It will add about 45,000 species of Micro-Lepidoptera to the national collection, which at present possesses only about 4,000 species of these small insects. In addition, Lord Walsingham is presenting to the nation an important library of the literature dealing with the subject. His previous gifts have comprised at least 15,000 specimens. Among these may be specially mentioned a collection of insects from California and a series of more than 1,000 moths of the family Pyralidæ. Another donation which forms a specially attractive feature of the museum is the collection of British butterflies and moths, in which the caterpillars, at various stages of their growth, are exhibited on their food-plants with the perfect insects. The preparation of the caterpillars for exhibition, an operation requiring a considerable amount of technical skill, was in great part the work of Lord Walsingham himself. The illustrations of the nesting habits of British birds include no fewer than 49 groups obtained and given by Lord Walsingham.

AT the University of Montana one of the features of the newly organized work in forestry is a short course for rangers employed in the United States Forest Service. By arrangement with the officers of District No. 1, with headquarters at Missoula, a number of men from each of the national forests in the district will be detailed for attendance on the courses, which will occupy the time of the rangers for the months of January, February and March, while the field work is suspended. About sixty men are expected to register for the courses this winter.

THE U. S. Geological Survey's summary of the mineral production of the United States in 1908, prepared by W. T. Thom, issued as an advance chapter of "Mineral Resources of the United States, Calendar Year 1908," shows a decline in the value of the country's mineral output amounting to about $476,000,000, or 23 per cent. The figures for 1907 and 1908 are $2,071,607,964 and $1,595,670,186, respectively. The loss is due to a decrease in the output of both metallic and non-metallic products. The most notable decreases among the metallic products were in the production of iron ores (30 per cent. in quantity and 38 per cent. in value) and of pig iron (38 per cent. in quantity and 52 per cent. in value). The production of bituminous coal decreased about 16 per cent. Gains are shown in the production of gold and in the quantity of copper produced, but this gain in quantity was accompanied by a loss in total value, due to the lower prices of copper. Petroleum showed a gain of about 8 per cent. in quantity and value, 179,000,000 barrels having been produced in 1908 and 166,000,000 barrels in 1907. Considerable gains in mineral production were made by several states. California gained 15 per cent., Florida 24 per cent., Louisiana 11 per cent., New Hampshire 16 per cent. and South Dakota 72 per cent. The losses, however, were out of proportion to the gains. Alabama lost nearly 33 per cent., Colorado 17 per cent., Illinois 15 per cent., Michigan 34 per cent., Montana 22 per cent., New Jersey 35 per cent., New York 33 per cent., Ohio 35 per cent., Pennsylvania 28 per cent., Virginia 32 per cent. and West Virginia 16 per cent.

THE annual report of the Liverpool Marine Biology Committee and the Port Erin Biological Station was submitted by Professor Herdman at a meeting of the Liverpool Bio-

logical Society on November 12. In the course of his address, according to the report in *Nature,* Professor Herdman gave an account of the work, both scientific and economic, carried out during the past year, such as the curator's report upon the hatching and setting free of more than seven millions of young plaice, making a total of 25½ millions during the six years the hatching has been in operation; the experiments in lobster rearing; Dr. Ward's investigations on the eggs and young larvæ of the plaice (illustrated by many very beautiful enlarged photographs); Mr. Gravely's work on the development of the brittle-star-fish; Dr. Herbert Roaf's researches on digestion in marine animals; Mr. Dakin's physico-chemical observations on the condition of the sea-water at different times in connection with the migrations of the food of fishes; Mr. Edwin Thompson's photomicrographs of various types of minute organisms in the sea; and Professor Herdman's own investigations into the detailed distribution of life in the sea. Some of the biological stations and establishments for fish culture in Canada and the United States were also described, and attention was directed to the American system of providing dormitories and dining halls for the students and researchers, and to the manner in which men of wealth in the states advance science by making large donations to such laboratories in order to defray the expenses of special investigations or marine and other explorations.

THE *Journal* of the American Medical Association summarizes recent vital statistics for England and France. It appears that the registrar-general's return for the quarter ending September again records a decreased birth-rate for England and Wales, the proportion being 25.4 annually, which is 2.5 below the average for the ten corresponding quarters and is the lowest for any third quarter of the year since the establishment of civil registration. On the other hand, the deaths were only 11.6 per 1,000, which was 3.4 below the average for the last ten years, and again the lowest on record for the period in question. Taking the two returns together, the natural increase in population by excess of births over deaths was 123,878, as against 123,197 in 1908. The low death-rate is all the more remarkable, as the weather conditions have been unfavorable. The summer months included only one substantial spell of fine seasonable weather. Thanks to the great attention which is now being paid to infant hygiene, the mortality of infants under 1 year showed the large decrease of 38.6 per cent. Statistics in regard to the fluctuation of population in France during the first semester of the present year have just been published. Here are the comparative figures of births and deaths for the first semester of the years 1908–9:

	1909	1908
Births	398,710	411,402
Deaths	426,913	401,894

Thus the number of births has diminished by 12,692, and at the same time the number of deaths has increased by 25,019. The population of France has diminished by 28,203, figures representing the excess of deaths over births. Almost all the departments of France have contributed to this diminution of the population, but the excess of deaths over births is often particularly marked in the departments which contain large cities, as the departments of the Seine (Paris), Rhône (Lyons), Gironde (Bordeaux), Bouches-du-Rhône (Marseilles), Haute-Garonne (Toulouse), etc. Only in some departments of the north and west is an excess of births over deaths recorded.

THE production of gold in the United States in 1908 was 4,574,340 fine ounces, valued at $94,560,000, an increase of 199.513 fine ounces over the production in 1907, which was 4,374,827 fine ounces, valued at $90,435.700. The production of silver in 1908 was 52,440,-800 fine ounces, valued at $28,050,600, a decrease in quantity and in value from 1907, when the production was 56,514,700 fine ounces, valued at $37,299,700. On the whole the gold-mining industry had in 1908 a prosperous year in spite of many adverse conditions of trade and finance. The production during the year is the largest annual output

yet recorded. The silver mining industry presents a condition far less satisfactory, owing to the low prices of silver, lead, copper and zinc. Important mines in Colorado and Utah found it difficult to make profits on low-grade ores, and large smelters in these states were closed during part of the year or were operated with reduced capacities. A temporary lack of demand for silver in India, and a very heavy production in Canada contributed to the depression in price. The average price per ounce during the year was 53 cents, as against 66 cents in 1907. The Geological Survey's report on gold and silver in 1908, prepared by Messrs. Waldemar Lindgren and H. D. McCaskey, may be had by applying to the director of the survey at Washington.

ACCORDING to a notice in the London *Times* the project described recently by Sir William Willcocks at a meeting of the Royal Geographical Society promises to be the most important engineering undertaking of the near future. An irrigation scheme is being planned for the rehabilitation of Mesopotamia upon such a scale that 3,000,000 acres of the best land in that country will be provided with water. If it is carried out, the Tigris, the Euphrates and the Akkar Kuf Lake will form part of a controlled system of canals, weirs and barrages, whereby the pernicious silt is to be separated, floods are to be prevented and wheat-bearing land is to be nourished with water. It is estimated that the cultivated area will be doubled, and that the crop of wheat along the Euphrates will be trebbled. The scheme would also result in a vast increase in the yield of cotton. Briefly, it consists of providing a means of escape for the flood waters of the Euphrates along the depressions of the Pison, but it also entails the construction of a great central canal, regulators to control the supply from the Euphrates at the head of the Sakhlawia, a weir on the Tigris, a canal for irrigation to the north of Baghdad, another canal along the right bank of the Tigris and the building of a railway along the left bank of this canal for the transport of the harvests. Moreover, the construction work would include a railway to connect Baghdad with the Mediterranean by a short and cheap route.

UNIVERSITY AND EDUCATIONAL NEWS

THE trustees of the University of Pennsylvania announce that Mr. Henry Phipps, of New York, founder of the Phipps Institute in Philadelphia, has presented to the university $500,000, to be used in the campaign against tuberculosis. The management of the Phipps Institute will be in the hands of the university, and the study, treatment and prevention of the disease will be continued in a new hospital to be erected at Seventh and Lombard Streets. Six years ago Henry Phipps founded the Phipps Institute for Tuberculosis Research in Philadelphia, with a large endowment. In 1908 he gave $500,000 to the Johns Hopkins University for the founding of a psychiatric clinic.

THE eleventh industrial fellowship at the University of Kansas has been established by the Pacific Coast Borax Company of Oakland, California, and will be known as the Borax fellowship. The amount which this company will pay to support the work of its fellow is $750. The purpose of the fellowship is to investigate the uses of borax and to discover if possible new commercial utility in this product.

THE cornerstone of the new science hall of Howard University was recently laid by Richard A. Ballinger, secretary of the interior. Addresses were delivered by Dr. Robert S. Woodward, president of the Carnegie Institution of Washington and Dr. Charles Wardell Stiles, director of the Rockefeller fund for combating the hook-worm disease. An appropriation of $90,000 was made by the last congress for the erection of this hall.

LECTURES in veterinary science are to be given in the College of Agriculture of the University of Wisconsin this year during the second semester as a result of the appointment of Dr. John Spencer, of Pulaski, Va., as special lecturer in veterinary science. In addition to his lectures Dr. Spencer will have

veterinary supervision of the university flocks and herds.

THE department of mining engineering of the University of Illinois has just issued its first circular of information. The course of study required for the degree of B.S. in mining engineering covers the usual period of four years. The technical studies relating to mining are begun in the sophomore year, mining principles in the first semester and earth and rock excavation in the second semester. In the junior year the study of mining methods, mine surveying and mine ventilation is pursued. In the senior year more time is devoted to the subjects relating particularly to mining. They are mechanical engineering of collieries, mine administration and organization, mining law, mining laboratory and economics of coal. Professor H. H. Stock, head of the department has been appointed a member of the Mine Commission by Governor Deneen. A Mine Explosion and Rescue Station has been established at the university under the direction of Mr. R. Y. Williams.

IT has been decided by Balliol College to offer next year an exhibition of £80 a year, tenable for two years, for the competition among students recommended by trade unions operating in Newcastle.

FOR the recently constituted degree of bachelor of science in agriculture at the University of Manchester, special courses have been prepared. The practical work will be carried on at the college of agriculture and horticulture at Holmes Chapel under the supervision of the principal, Mr. T. J. Young, who has been appointed a lecturer in the department of agriculture in the university.

THE professorship of natural history at the College of the City of New York has been filled by the promotion of Dr. Ivin Sickels, assistant professor, who since the death of Professor Stratford has directed the affairs of the department. Professor C.-E. A. Winslow, of the Massachusetts Institute of Technology, has accepted an appointment as associate professor of biology in the College of the City of New York and has been made curator of public health in the American Museum of Natural History. Professor Winslow is lecturing at the University of Chicago, on leave of absence from the institute during January, February and March, returns to Technology for the rest of the spring term and goes to New York in September.

DR. JOSEPH EVANS, of Philadelphia, has been appointed professor of clinical medicine and medical adviser to the students of the University of Wisconsin.

MR. HAROLD K. BARROWS, of the U. S. Geological Survey, has been appointed to the position of associate professor of hydraulic engineering at the Massachusetts Institute of Technology, made vacant by the resignation of Professor William E. Mott.

DISCUSSION AND CORRESPONDENCE

THE TEACHING OF ELEMENTARY DYNAMICS IN THE HIGH SCHOOL

TO THE EDITOR OF SCIENCE: So the teachers of physics have at last recognized and confessed the fact that they do not know how to teach elementary dynamics (or kinetics) to high school students, and they think they have discovered the cause of their trouble, viz., the multiplicity of forms in which the "youngster" is taught the familiar formula

$$\text{force} = \text{mass} \times \text{acceleration},$$

one of these forms being

$$\text{force (poundals)} = \text{mass (pounds)} \times \text{accel. (ft. per sec. per sec.)}$$[1]

Instead of drawing the obvious conclusion, "let us simplify the subject and get rid of some of the forms, especially the one with the 'poundal' in it," the physicists are actually talking of running away from the difficulty. A majority of a conference of physicists have signed a statement which proposes among other things "that colleges should require of the schools no quantitative treatment of kinetics, or the behavior of matter undergoing acceleration."

To this lame and impotent conclusion have the teachers of physics come after years of blindly following the modern text-books. The aim of these text-books seems to be not to make

[1] See Professor Edwin Hall's paper in SCIENCE, October 29.

the subject of dynamics clear and interesting to the student, but to muddle it as much as possible with "poundals," "gee pounds," dynes, etc., and with such statements as "force is the time-rate of acceleration," etc. When the student gets into college he has to forget much that he has been trying to learn before he can get the clear concepts of dynamics that are necessary to further progress in the subject.

I have taught elementary dynamics to some high school students who were floundering with the mysteries of the text-book, and have also taught it to college students who combined a parrot-like memory of the words of the book they had used with total inability to make intelligent use of first principles. It may be of interest to some readers to have a short syllabus of my method of beginning the subject. Here it is:

Matter.—A stone is suspended by an elastic cord from a nail driven into a projecting shelf. The stone is a piece of matter. Define matter. Quantity of matter, determined by measuring (bulk or volume), or by weighing (weight). Bulk is inconstant and inexact, varying with temperature, porosity, etc. Weight (determined by weighing on an even balance scale) is exact and constant. The weight of the stone is W *pounds*. The unit of weight is the pound. The standard pound is kept in London and copies are made of it.

Force.—The cord is stretched when the stone is hung on it. Measure the stretch per foot of length. Why is the cord stretched by the stone? Attraction of the earth's gravitation. But the cord may be stretched by pulling it between the two hands horizontally. Also the cord with the stone or weight hung from it will return to its unstretched length if the stone be pushed upwards by the hand through a distance equal to the stretch. The pull of the earth upon the stone (gravitation), the opposite pull of the elastic cord on the stone, the pull of the hands, the push upwards by the hand, each is called by the name *force*. Force is defined as a pull or a push, something that causes or tends to cause either motion, or a change in the velocity or direction of motion. As the weight of a body (quantity of matter) is stated in pounds, so the amount of a force is also stated in pounds, a pound of force being defined as equal to the force with which the earth's gravitation attracts a one-pound weight. Force is generally represented by F. The force of the earth's gravitation acting on the stone whose weight is W pounds, is also W pounds, or $F = W$.[3] Force may be measured or weighed by a spring balance graduated in pounds, or by counterpoising it with weighted levers (illustration, the lever safety valve), or in other ways. This force varies somewhat with the latitude of the place, being about $1/1000$ part greater at London than at Philadelphia, but in ordinary and elementary problems relating to force, this difference is neglected. In advanced studies it will be considered.

We have thus far considered two different things, matter and force and the method of determining the quantity of each; W and F.

Space, Time.—Now let the cord be suddenly detached from the stone. The stone falls to the ground. It traverses a certain distance, which we call space, S, measured in feet, during a certain time, T, in seconds. We now have all four of the elements, or concepts, of dynamics, matter, force, space, time, represented by W, F, S, T. The whole science of dynamics is built on these four elements, and it may be defined as the relations existing between them when force acts on matter through space and in time.

Velocity, etc., of Falling Bodies.—The simplest case of the relation of these elements is that of a falling body, when the force acting in pounds is numerically equal to the pounds weight, or quantity of matter W. By experiment it has been found that when a body falls freely in air

for seconds $T =$	1	2	3	4	5
it will fall in each of the several seconds 16.1 ft. $\times$	1	3	5	7	9
And the total fall at the end of each second is $S = 16.1$ ft. $\times$	1	4	9	16	25

[3] The term "weight" is correctly used both as a measure of a quantity of matter and as a measure of the force with which that quantity would be attracted by the earth at London.

The velocity at the end of each second is $V = 32.2$ ft. per second $\times$	1	2	3	4	5
The increase of velocity per second is 32.2 ft. per second $\times$	1	1	1	1	1

Velocity, V, is here defined as the rate of motion. It is the space traversed divided by the time, $S \div T$, if the velocity is uniform. If it is not uniform, but increases at a constant rate, as in falling bodies, then the average velocity during any time, T, is $S \div T$. If the velocity is 0 at the beginning of any time T and V at the end of the time, then $V = 2S \div T$. The relation of time, space and velocity when the velocity is uniformly increasing may be illustrated by a right-angled triangle in which the bases are T and V and the area S.

$$S = \tfrac{1}{2}VT, \quad V = 2S \div T \tag{1}$$

Expressing algebraically the results given in the above table we find

Total fall, $S = 16.1 \times T^2$, or if

$$g = 32.2, \quad S = \tfrac{1}{2}gT^2 \tag{2}$$

Velocity at the end of the time T,

$$V = 32.2 \times T = gT \tag{3}$$

Velocity at the end of the fall S,

$$V = \sqrt{2 \times 32.2 \times S} = \sqrt{2gS} \tag{4}$$

The last equation is commonly written $V = \sqrt{2gH}$, in which H = height of fall.

Acceleration.—A, $= V \div T$ = rate of increase of velocity, = 32.2 ft. per second in each second in the case of falling bodies at London. This quantity, 32.2 ft. per second per second, is commonly represented by g, and it is called the acceleration due to the earth's gravitation, or more briefly, the acceleration due to gravity.

Force causing Acceleration.—In the case of a falling body, a force which equals the weight W acts on the weight and causes it to move with an acceleration $A = 32.2$ ft. per sec. per sec. Suppose the weight is not a falling body, but a weight supported on frictionless rollers on a level plane, or a body floating in still water, and a constant force is applied to it horizontally, say by a cord the tension in which is kept constant and measured by a spring balance. What then will be the acceleration? The force is the cause of acceleration, and the acceleration is the effect of force. In general an effect is proportional to its cause. If the force applied to the weight is one tenth of the force of gravity, then the acceleration is one tenth that which would be caused by gravity, or 0.1 g or 3.22 ft. per sec. per sec.

Let W = weight, g = the acceleration that would be given by a force equal to W, A = the acceleration that would be given by any other force F, then

$$A : g :: F : W,$$

or the acceleration produced by any force F is to the acceleration due to gravity as the force F is to the weight of the body, or

$$A = gF/W. \tag{5}$$

From this equation we see that the acceleration is proportional to the force, and inversely proportional to the weight. Illustrate this by Atwood's machine and by experiments on weights supported on rollers or floating in water. Writing A instead of g in the equations (2), (3) and (4), they become general and apply to all cases of uniformly accelerated motion, as well as to falling bodies.

Total space traversed in time T, $S = \tfrac{1}{2}AT^2$ (6)

Velocity at the end of the time T, $V = AT$ (7)

Velocity at the end of the space S,

$$V = \sqrt{2AS} \tag{8}$$

Example (1), A boat in a canal weighs 20,000 pounds. If a boy pulls it with a string with a constant pull of 10 pounds, what velocity will the boat have acquired at the end of a minute, friction being neglected? Ans. 0.966 foot per second. (2) If an air gun has a bore 5 feet long and 1 square inch area, a bullet weighing one pound sliding frictionless in the bore, and propelled by compressed air supplied from a large reservoir at a constant pressure of 2,000 pounds per square inch behind the bullet, what will be the velocity of the bullet as it leaves the gun? Ans. 802.5 feet per second.

In the equation (5) $A = gF/W$, F and W are known and A is to be found, but if the acceleration is known, and also either one of the other two quantities, F or W, the third quantity may be found. Thus,

$$WA = gF, \text{ whence } W = gF/A \tag{9}$$

and

$$F = W/g \times A. \tag{10}$$

That is if a force produces a uniform accel-

eration A in a body whose weight is W, then the force in pounds is numerically equal to the weight in pounds divided by 32.2 and multiplied by the acceleration in feet per second per second.

Work, Energy, Effect of Force Acting through Space.—If a weight W is lifted against gravity through the height H, the product WH is called work, in foot-pounds. It is equal to the force exerted through distance, or $FS = WH = WS$. If the body falls through the space S, it acquires a velocity $\sqrt{2gS}$. If it is moved a distance S by a constant force F, other than the force of gravity, with an acceleration A, then the acquired velocity $V = \sqrt{2AS}$, from which $S = V^2/2A$. Taking this equation together with equation (10) $F = W/g \times A$, we find

$$FS = \tfrac{1}{2}W/g \times V^2. \tag{11}$$

Work is defined as the sustained exertion of force through space, and its quantity, measured in foot-pounds, is the product of the force by the space, $F \times S$. If the force is exerted to lift a weight W through the height H, and the weight is stored at the top of the lift, it is evident that it is capable of being used to do work (illustrate). This capacity of a body at rest for doing work is called *potential energy.* If the body falls through the height H, it acquires a velocity $\sqrt{2gH}$, and it is capable of doing work by reason of that velocity, on any body which may offer resistance to its motion. This capacity is known as *kinetic energy,* or energy of motion, and its quantity is expressed by the second term of equation (11), viz., $\tfrac{1}{2}(W/g)V^2$ and is stated in foot-pounds. Let us collect together some of these equations for review:

(5) Acceleration in terms of weight and force,
$$A = Fg \div W,$$
(10) Force in terms of weight and acceleration,
$$F = W/g \times A,$$
(11) Energy in terms of weight and velocity,
$$FS = \tfrac{1}{2}W/g \times V^2.$$

If we replace the expression $W \div g$ by the letter M, the equations take a simpler form:

$$A = F \div M, \tag{5a}$$

$$F = MA, \tag{10a}$$

$$FS = \tfrac{1}{2}MV^2. \tag{11a}$$

Mass.—It is convenient to call the quantity $M = W/g$ by a name, and the name "mass" has been given to it, although this name is perhaps unfortunate, since the word mass is also used in other senses. Thus it is commonly used to mean an indefinite quantity of matter, as a lump or portion. It is also used by many text-book writers in the sense in which we have used the word weight, for a definite quantity of matter stated in pounds, and these writers try to restrict the word weight to mean only the force with which the earth attracts matter. (Do not tell the student that "the engineer's unit of mass is 32.2 pounds." The engineer has no such unit. When he weighs a quantity of matter he records the result as a weight, and his unit is a pound.)

Giving the word mass to the quantity W/g, the above equations may be read thus:

(5a) Acceleration equals force divided by mass,
(10a) Force equals mass $\times$ acceleration,
(11a) Force into space $= \tfrac{1}{2}$ the product of the mass by the square of the velocity.

Momentum.—From equation (7) $A = V/T$; substituting this value of A in equation (10a) $F = MA$, we obtain $F = MV/T$, whence

$$FT = MV. \tag{12}$$

This may be explained to mean that a force F acting constantly on a mass M ($= W/g$) which is free to move, will in the time, T, give it a velocity V. The quantity FT is sometimes called *impulse,* and the quantity MV *momentum,* and the equation is said to show the equality of impulse and momentum. (In some books momentum is called quantity of motion, but this is an error; it is merely the product of mass and velocity.)

The following equations should be memorized, as they are constantly needed in solving problems in mechanics:

$V = \sqrt{2gH}$, velocity of falling bodies,
$F = MA = MV/T$, force equals mass $\times$ acceleration,
$FS = \tfrac{1}{2}MV^2$, force into space equals energy,
$FT = MV$, force into time equals momentum.

By these four equations and their algebraic

transformations, nearly all problems in dynamics (except those relating to impact) may be solved. The sign $=$ is to be considered as meaning only "is numerically equivalent to," and never as meaning "is," as in the inaccurate statement "force is the time rate of momentum."

The main ideas in the above syllabus are:

1. That words should be used as far as possible in their most common meaning; thus, "weight," and not "mass," is the word that means, in ordinary language, the quantity of matter expressed in pounds.

2. That the English system of weights and measures is used until the subject has been carried as far as this syllabus extends. The metric system can now be used with the same equations, and the C.G.S. system with its "dimensions" postponed to the end of the course.

3. An attempt has been made to use no more technical terms and definitions than are absolutely necessary. The poundal and the geepound are ignored and the dyne and the erg postponed.

4. Force is treated as an entity, capable of being measured directly as matter and space are, and not as a mere mathematical function derived from length, mass and time.

5. The word "mass," which gives most difficulty to younger students, is postponed till near the end of the syllabus, and is then introduced merely as a convenient substitute for W/g. The word weight is explained to mean quantity of matter as determined by weighing it on an even balance scale (not on a spring balance). When W is so weighed, the London value of g is always used in finding $M = W/g$.

6. In teaching a class, after the preliminary study of the derivation of the equations is finished, I would put them on the blackboard and let them remain there for handy reference when solving problems. A great number of problems should be solved by the class.

I am aware that much of what I have written above will be considered rank heresy by many teachers of physics, but I submit that since in the past they have failed to teach dynamics in such a manner that the students can grasp the subject and use it in college, it is high time they changed their methods and try the method that was successfully used fifty years ago.

WM. KENT

INFLUENCE OF OXYGEN ON THE VALUE OF COAL

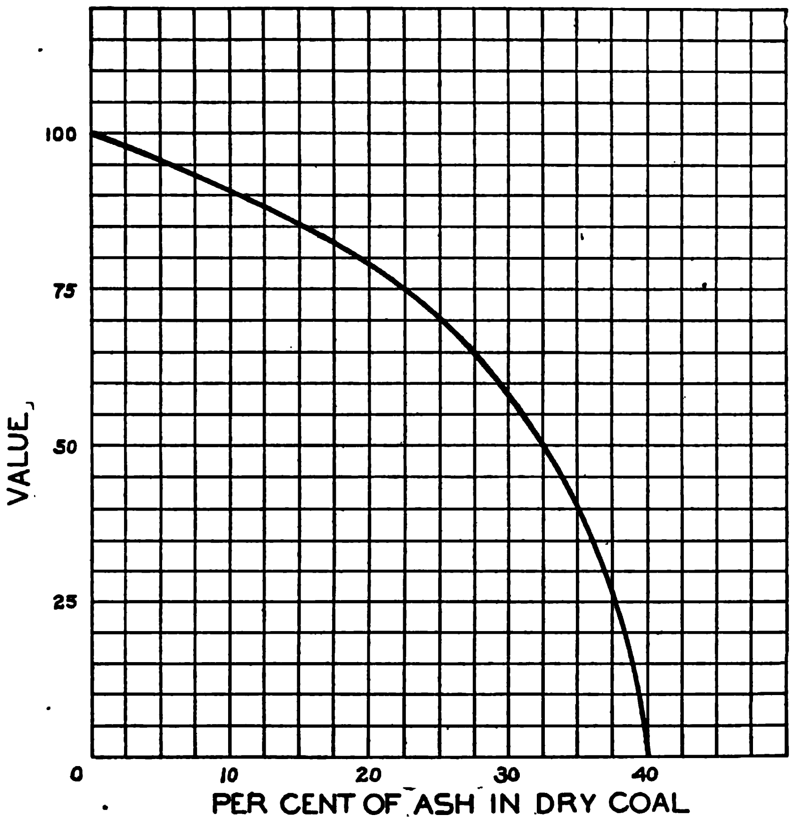
TO THE EDITOR OF SCIENCE: Dr. David White, in Bulletin No. 382 of the United States Geological Survey, under the title of "Oxygen in Coal," has presented some interesting and valuable matter. There are certain features, however, which may profitably have more exact examinations.

Dr. White shows that the presence of oxygen in coal has an effect equal to that of ash in reducing the heating power value of the fuel; it is, of course, true that it displaces an amount of combustible matter equal to that of ash. There is some question, however, as to what is implied by the statement. As far as the combustion process is concerned, oxygen is present as a gas and aside from displacing a corresponding weight of combustible matter in the coal, its only harmful influence is in carrying away a small amount of heat in its exit to the chimney; while the presence of ash, on the other hand, has a very harmful influence on the result produced in combustion, because ash makes clinker and otherwise obstructs the fire.

W. L. Abbott[1] has shown in a well-conducted series of experiments that the value of fuel, for the purpose of making steam, drops to zero when the ash content is equal to 40 per cent., as shown by the accompanying diagram. Therefore, it appears that ash is enormously more harmful than oxygen, because if the latter was present to the extent of 40 per cent. the loss of heat from this cause would not exceed 6 or 7 per cent.

While particular emphasis has been placed upon the presence of oxygen as an element by Dr. White, I would prefer considering the matter from the standpoint of the total inert volatile matter instead of simply that of oxygen

[1] *Journal of the Western Society of Engineers*, Vol. XI., p. 529.



alone. The argument may be made clear by the two following tables:

ELEMENTS IN COAL

Combustible	*Non-combustible*
Carbon.	Oxygen.
Hydrogen.	Nitrogen.
Sulphur.	

COMPOSITION OF COAL

Combustible	*Non-combustible*
Carbon.	Water of combination.
Available hydrogen.	Nitrogen.
Sulphur.	

The first table presents a list of elements in coal and by this pure coal is meant, or, in other words, free from ash and moisture. In the second tabulation it will be observed that no oxygen is listed, but a new constituent water of combination takes its place. Our conception of the presence of oxygen in coal is that it is all in combination with hydrogen. The table also shows hydrogen which is available in combustion for heat production. Thus, when values are given upon this basis, the inert volatile matter which contains oxygen and hydrogen as water of combination, becomes a larger quantity than the oxygen figure which Dr. White has employed.

A. BEMENT

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ALLIGATOR MISSISSIPPIENSIS IN OKLAHOMA

THE occurrence of any species of reptile at a considerable distance beyond its usual or recorded range is a matter of general zoological interest. The capture of *Alligator mississippiensis* Daudin in central Oklahoma under circumstances which render it very improbable that the individual had ever been in captivity seems, therefore, worthy of record. The specimen was taken in a "lake" or bayou of the South Canadian River within five miles of the State University of Oklahoma, at Nor-

man. It was secured by a farmer, who presented it to the university museum through Dr. A. H. Van Vleet. Its skeleton has been preserved, and a life-like model, full size, was made and is now in the university museum. The specimen was a female, slightly over four and one half feet in length from tip to tip. It had been seen in the locality where taken, by a number of persons at various times for at least three years previous to its capture.

There is no record nor tradition of an alligator ever having escaped or been liberated (or even held captive) in this vicinity, and it is quite unlikely that such a thing could have occurred in what was formerly the Indian Territory. It seems altogether probable, therefore, that this individual had traveled up the Arkansas River to the mouth of the Canadian, and thence up the latter to the vicinity of Norman, some three hundred and fifty to four hundred miles west of the Arkansas-Oklahoma state line. The Canadian River is not a navigable stream and for most of the year is only a small meandering creek in a wide valley well filled up with sand. It is subject to numerous freshets, and frequently changes its course, so that "lakes" or bayous are numerous. The larger of such bayous apparently would make an admirable habitat for this species.

It is useless to speculate on the causes which impelled this individual to make such a journey, but it is important that it was apparently successfully maintaining its existence in its new station until man's interference put an end to one of nature's experiments.

H. H. LANE

STATE UNIVERSITY OF OKLAHOMA,
NORMAN, OKLA.,
November 26, 1909

QUOTATIONS

PRESIDENT SCHURMAN AND THE FUTURE OF CORNELL UNIVERSITY

PRESIDENT SCHURMAN is determined to put every department of Cornell University under the control of the Legislature at Albany. He has hinted such a purpose in the past, and now he makes it clear. The first title in his report to the Board of Trustees is "State Support and Control of the University." Under this heading the president indicates that he would welcome state control and shows how it may easily be brought about; he does not explain how state *support* may also be obtained, but leaves it to be inferred that he thinks the state will inevitably support what it controls.

The president has done well to bring this question into the open. The alumni of the university are entitled to a voice in deciding so vital a matter of policy. Will they be found to favor the president's plan? We think not. But if they are opposed to it they must make themselves heard, or the president will unquestionably take their silence for consent. The alumni have representatives on the Board of Trustees whose opinion they, presumably, can sway, but this question is too important to be debated and decided behind closed doors. It should be discussed in the open. There are difficulties and dangers in the university's path if it follows President Schurman on his road to Albany. Are there substantial rewards at the end of the journey? The university will hope to make the state its benefactor. But will it not put behind it for all time the hope of any substantial benefactions from private sources? Which road shall we take? This paper hopes to have an opportunity to print some opinions on the subject.—*Cornell Alumni News.*

SCIENTIFIC BOOKS

Life Histories of Northern Animals: An Account of the Mammals of Manitoba. By ERNEST THOMPSON SETON, Naturalist to the Government of Manitoba. With 68 maps and 560 drawings by the author. New York, Charles Scribner's Sons. 1909. Two volumes, royal 8vo. Vol. I., Grass-eaters, pp. i–xxx, 1–673, pll. i–xlvi, text illust. 1–182 and maps 1–38. Vol. II., Flesh-eaters, pp. i–xii, 675–1267, pll. xlvii–c, text illust. 183–267 and maps 39–68. $18 net per set.

The secondary title of Mr. Seton's great work, "An Account of the Mammals of Manitoba," more definitely expresses its scope and character than the leading title, "Life Histor-

ies of Northern Animals," for the work deals almost exclusively with the mammals of Manitoba with such reference to those of North America at large as is required in the full treatment of species which in most instances have a wide North American range. Although the author has spent many years in Manitoba, and is thus an authority from first-hand knowledge on the mammals of this province, his studies of the species in life have been made in large part at localities remote from Manitoba—from the eastern United States, Colorado, New Mexico, Wyoming and California northward to Great Slave Lake. This is, of course, as it should be—an intimate acquaintance with the species of a local area supplemented by studies of the same species in their wider distribution. His life histories of the mammals of Manitoba are thus their life histories as species, with special reference to their representation in Manitoba.

The present work is notable in many ways, some thirteen hundred pages, one hundred plates, two hundred and sixty-seven text illustrations[1] and sixty-eight maps being employed to elucidate the history of sixty species. Each history may be characterized as an elaborate monograph of the habits and distribution of the species to which it relates. Technicalities are reduced to a minimum, and are introduced only so far as to give the current technical name of the species and its systematic relations; the descriptions are brief but accurately diagnostic, and, with the profuse illustrations, are sufficient for the identification of the species and to show its external characteristics.

Mr. Seton has long been known to those who have kept in touch with his work as an ardent and painstaking student of animal life, and also as a natural history draughtsman of rare ability. His fitness for the task here undertaken is thus evident alike in the text and in the illustrations.

A few words from the author's preface and introduction will serve to present his viewpoint and aim in preparing the work. He says:

[1] As numbered, but in many cases half a dozen or more figures are included under one number.

This aims to be a book of popular Natural History on a strictly scientific basis. . . . Although I have limited the scope to the 60 species found in Manitoba, this takes in all the large land mammals of the United States, except about a dozen, including five of the big game. Having followed these 60 into all parts of their ranges, I have virtually included the Continent from Labrador to California. . . . Thirty years of personal observations are herein set forth; every known fact bearing on the habits of these animals has, so far as possible, been presented, and everything in my power has been done to make this a serious, painstaking, loving attempt to penetrate the intimate side of the animals' lives—the side that has so long been overlooked, because until lately we have persistently regarded wild things as mere living targets and have seen in them nothing but savage or timorous creatures, killing, or escaping being killed, quite forgetting that they have their homes, their mates, their problems and their sorrows—in short, a home-life that is their real life, and very often much larger and more important than that of which our hostile standpoint has given us such fleeting glimpses. . . . My theme is *the living animal*. . . .

No one who believes in Evolution can doubt that man's mind, as well as his body, had its origin in the animals below him. Otherwise expressed, we may say that: Just as surely as we find among the wild animals the germs or beginnings of man's material make-up, so surely may we find there also the foundations and possibilities of what he has attained to in the world of mind. This thought lends new interest to the doings of animals in their home-life, and I have sought among these our lesser brethren for evidence of it—in the rudiments of speech, sign-language, musical sense, esthetics, amusements, home-making, social system, sanitation, wed-law, morals, personal and territorial property law, etc. . . . As much as possible I have kept my theories apart from my facts, in order that the reader may judge the former for himself.

In the introduction he further unfolds the plan of treatment, and states that each animal is considered "under some thirty different heads" or sections, but in very few cases are they all employed in connection with any one animal, their absence indicating that nothing is known respecting these particular points. Among those most commonly employed are:

tracks, speed, mind, environment, range, migrations, numbers, food, property, storage habit, sociability, means of communication, senses, amusements, nesting, homes, sanitation, training of the young, morality, enemies and disease, odd partnerships, commensalism, etc. These subtitles appear as side-headings in the text under the species, having been first defined and explained in the introduction.

To speak more in detail, the introduction is one of the most important parts of the book, beginning as it does with a Sketch of the Physical Features of Manitoba (pp. 1–11), followed by a section on The Faunal Areas and Life Zones of Canada (pp. 11–22), and a statement of the General Plan of Treatment for Each Species (pp. 22–34). Under the first section, treating of the geology and physical features, a map illustrates the distribution of the deciduous and coniferous forests, the sandhills and marshes of the province. The section devoted to faunal areas is illustrated by a faunal map of North America, excluding the tropics, the continent being divided into three primary regions, arctic, temperate and tropical, and these again into smaller areas designated as faunas and subfaunas. The lines of division are mainly in accord with those recognized by other recent authorities, corrected in certain details by the author's own researches, and with several new minor subdivisions. A diagram on page 21 shows the relationships of the zones and faunas of the temperate region, shaded to indicate the relative amount of rainfall in each. His two primary boundary lines, separating the temperate region respectively from the arctic and tropical, are the Arctic Circle and the Tropic of Cancer, the first being, roughly, the southern limit of perpetual frost in ground exposed to the direct rays of the sun, the other the line where frost ceases.

Under Plan of Treatment, each subtitle of the life history of a species is concisely defined. It is here said: "The environment is the creator of the animal, the mold in which each species was cast"—of course in the ultimate sense. "The range of the animal," he adds, "is part of its environment, and long ago I came to the conclusion that every animal is changing its range." That such is the case in Manitoba, with respect to several species, he brings forward indubitable evidence. Mr. Seton first became a resident of Manitoba in 1882, at which date certain species were entirely absent from the province which have since not only entered it, some from the southeast and some from the southwest, but have possessed themselves of considerable portions of its southern border. These are species which for the most part find in the opening up of new areas to agriculture favorable changes in environment.

The amount of space given to the different species varies in accordance with their importance and interest, or, perhaps more correctly, with the amount of information available respecting them. Thus some of the smaller rodents have as much space given to them as is given to the elk or wapiti, while still more is naturally given to the beaver. As an illustration of the method and fulness of treatment, the wapiti and pocket gopher may be cited. The account of the former occupies 30 pages, with a full-page plate of the animal, a full-page map showing its distribution and three full pages of figures illustrating the antlers (24 figures). The text gives first its names (English vernacular, technical, French Canadian and Indian); its family, generic and specific characters (the latter including measurements, weight, color); a list of the forms (subspecies) now recognized; a history of its early discovery and its early names, followed by the "life history," under the subheadings range, ancient numbers (estimated at 10,000,000), dwindling, in Manitoba, present number (estimated at 45,650 in 1907), signs, tracks (illustrated), wallows, dance, mating, antlers, record heads, the war-cry, pugnacity, the battle, the finish.

In the case of the pocket gopher, a full-page plate is given of the animal (life-size), a full-page map showing the range of the gopher family and a small map of the range of the northern pocket gopher in Manitoba; sketches of the fore and hind feet; life studies of the animal, showing numerous poses and attitudes in burrowing; a full-page and several other smaller diagrams of its burrows and tunnels under the snow, and others showing the fre-

quency of its mounds on given areas. The text and drawings are based partly on allied species inhabiting Colorado and California. Several pages of the text are devoted to its utility in making loam, and incidentally to showing the fallacy of Darwin's assumption that earthworms are found throughout the world, and are the chief agency in soil formation. Although in vast regions of the interior of North America there exists a stratum of humus, sometimes several feet in thickness, "earthworms are not native to any part of America south of the Great Slave Lake or west of the immediate Mississippi Valley," execept where they have been introduced.

This detailed, topical method of treatment is followed throughout the book, the illustrations varying with the character of the species treated, and include details of structure, poses of the animal, plans of runways, tracks, burrows, excrement (scatology), means of defense, etc.

The illustrations are usually the author's own, from sketches from life or from nature, the exceptions being usually skulls, which are mainly copied (with acknowledgments) from technical papers issued by the Biological Survey. The maps are the result of careful research, the ranges being compiled from the literature of the subject plus the author's personal information, the actual places of known capture being often indicated by dots within an admittedly hypothetical outline of the supposed range.

The author sticks closely to his text—the habits of the animals—to the exclusion of hunting stories and incidents of travel. Although the work is so voluminous the style is graphic and concise; the matter is pertinent and well stated, and there is no padding. There are some quotations from previous authors, some previously unpublished information from correspondents, credit for facts and data, published or unpublished, being bounteously given, but the great bulk of the matter is a record of the author's own observations and field explorations, carried on for a long series of years and over a wide range of country. As a contribution to the life histories of North American mammals it is without a rival, and beyond comparison the best work of its kind that has ever been written. Indeed, it is safe to say that nothing having the same scope and detail, either in text or illustrations, has ever before been attempted. These two ponderous volumes are a monument to the author's persistence and zeal through many long years of affectionate search for knowledge of the habits and intimate home life of our American mammals, to which the publishers have contributed a setting worthy of the subject.

J. A. ALLEN
AMERICAN MUSEUM OF NATURAL HISTORY,
NEW YORK CITY

The Green Bug and its Natural Enemies. By Professor S. J. HUNTER. Bulletin of the University of Kansas, Vol. IX., No. 2.

This, the most voluminous study of the parasitism of a plant louse thus far reported, is worthy of careful attention. The rapid spread of the recently imported *Toxoptera graminum* from Europe is well presented and the illustrations of the structure of this and the related native species are quite satisfactory. The most useful parts of the work are the elaborate breeding experiments both on the plant louse and on its most abundant parasite *Lysiphlebus tritici*. Indeed, the publication affords the best data we have at hand for the discussion of the question of the efficiency of parasites. Not a little of the work is devoted to a defense of the author's claims as to the results of an aggressive campaign in which he distributed nearly 9,000 boxes of these parasites.

The author is very thoroughly convinced that the parasites were effective, saying (p. 8): "That this parasite not only controlled, but in many cases practically exterminated, the green bug last season, no one questions," and (p. 24): "Professor Glenn on the basis of twenty-five fold increase estimates that one female parasite placed with 2,000 adult green bugs just beginning to reproduce would exterminate them in twenty-five days, and one female with 10,000 such adults would exterminate them in thirty days."

The data presented hardly support the contention of the author, however, as will be shown below. He considers the parasite to belong particularly with this species of aphis, saying (p. 163): "It appears that *Lysiphlebus* does not perpetuate itself and maintain a general distribution on these other hosts," though it was first described from Missouri in 1888, and this particular plant louse was not recorded as far west as Indiana until 1890.

He recognizes the importance of weather conditions and states (p. 9): "The green bug continues to be active and reproductive at a lower temperature than does this parasite," thus giving the plant louse a start in the spring, and his assistant, Professor Glenn, says in the appendix on the "influence of climate," referring to the plant louse (p. 180), "it can not endure the high temperatures which prevail in summer," and in reference to the parasite (p. 182): "During the hot months of July and August, they decrease in numbers because of a lack of hosts, since the green bugs can not endure temperatures much above 100° F."

Since the aphid appears thus to have a lower optimum temperature it is most favorable to the parasite to compare the shortest period of development of each, which is for the aphid 5 days, for the parasite 7 days. Earlier in the year the intervals given are 11.5 and 17.69 days, respectively. The large amount of data make the average rate of reproduction appear to be very reliable and for the purpose of calculation we may use the round numbers 2 per day for twenty-five days for the aphis and 8 per day for five days for the parasite. This is favorable to the latter, the actual figures being a total of 59 and 38 descendants, respectively, for the summer condition. Three fourths of the parasites are counted female, though the actual number is only two thirds.

The following table gives the results of a calculation made by me and based on the figures given above.

In explanation of the table it may be said that only the large aphids are parasitized and nearly 85 per cent. are young insects when they are increasing at full capacity. Since one aphid produces 65,000 in 29 days and 95,000 in 30 days, the difference between these figures represents the descendants of the first two young insects and the ratio between these figures (68.5 per cent.) gives the reproductive power of the adult insect, which alone is liable to parasitization. The last column is obtained by dividing the figures showing egg-laying power by the number of adults (found by counting back five lines in the first column) and multiplying the quotient by the reproductive power of the adults. Thus the killing of 8 insects the second day affects the total of progeny the same as the killing of 5.92 on the first day, before the young had been produced. Adding the last column gives us the total result of the work of the parasite for any date within the month. The total for the month is 117.82. Had this number been killed the first day, the result on the total progeny would have been the same as that secured by killing over 700,000 plant lice and attaching the mummies of those dead plant lice to wheat stalks.

Day	Aphid		Parasite	
	Total	Reproducing Power of Adult	Egg-laying Power	Efficiency
1	1	100 %	8	8
2	3	68.5	8	5.92
3	5	47	8	3.76
4	7	32.2	8	2.57
5	9	22.8	8	1.82
6	11	15.7		
7	17	32.4		
8	27	37.5	48	3.5
9	41	37.2	96	5.5
10	59	32.5	144	5.15
11	81	26.9	192	4.7
12	115	28.5	240	4.2
13	169	31.1	192	2.05
14	251	31.7	144	1.11
15	369	31.8	384	2.1
16	531	31.1	908	3.8
17	761		1,727	4.7
18	1,099		2,876	5.36
19	1,601		4,336	5.4
20	2,339		5,200	4.42
21	3,401		5,488	3.24
22	4,933		6,952	3.19
23	7,131	31.4	11,258	3.22
24	10,333		20,162	3.92
25	15,011		36,266	4.9
26	21,813		61,418	5.69
27	30,657		90,314	5.76
28	44,907		117,794	5.18
29	65,561		149,162	4.53
30	95,571		199,454	4.17

The total effect of the parasite has scarcely more than 1 per cent. of the efficiency claimed for it in the publication under consideration, even though this is figured on a 40-fold increase instead of 25-fold. In every particular the assumptions upon which the above table is based are more favorable for the parasite than the experimental data presented by Mr. Hunter justify. And, moreover, the efficiency of the parasite does not increase by any such proportion as is generally assumed, the weekly averages only varying from each other by a small fraction, showing that years would have to elapse before the parasite would reach the efficiency supposed to be attained in twenty-five days or a month.

Of course, other factors enter into the problem, but the point that this calculation demonstrates is that these other factors are so much more important that, as compared with them, the work of the parasite is a negligible factor.

As corroborative evidence the author quotes Professor Marchal's account of the efficiency of the Australian ladybird against the cottony cushion scale. It may be instructive to state that during the last eighteen years this supposedly suppressed scale insect has figured as largely in the correspondence of the entomological department of the University of California as any scale existing in the state, and that on the university grounds and in the surrounding region it is now and has been all these years the most injurious scale insect present with the possible exception of the black scale.

Nearly all previous discussions of the efficiency of parasites or predaceous insects have been records of impressions instead of the presentation of experimental data. This author has accumulated a splendid lot of data, but has not used it. Like the others of us, he has been so impressed with the evidence he saw in the form of innumerable plant-louse mummies that he failed to grasp the importance of other conditions, probably largely meteorological, which might have caused the disappearance of the lice equally as soon had there been no parasites present. Aside from this one question of interpretation the work will be of great value to subsequent students of parasitism.

C. W. WOODWORTH
UNIVERSITY OF CALIFORNIA

Geology of the City of New York. By L. P. GRATACAP. Third edition. 8vo, pp. x + 232, 65 figs., 4 maps. New York, Henry Holt and Co. 1909. $2.50.

Gratacap's "Geology of the City of New York" was originally issued in 1901 as a pamphlet of 82 pages, specially designed for teachers of science, for pupils in the schools of the city and for the general reader to whom the metropolitan district furnished an attractive field of observation and study. The American Museum of Natural History conducts most commendable series of lectures for the teachers of the city and the manual found in them a constituency greatly needing just such a work. With the second edition the text was expanded to 119 pages, and now with the third the size of page is reduced from royal octavo to the more convenient octavo size and is expanded to embrace the latest results of study in the district. Practically a new book has been prepared.

The work opens with a general introduction intended to place the reader in command of the facts of stratigraphical classification, and, since the area is a metamorphic one, with the general principles and processes of this branch of geology. Manhattan Island is then described in detail; its topography, its rocks, its waterways, its minerals, etc. The boroughs of Brooklyn and Queens are next treated in a similar but much less detailed manner. Being covered with glacial drift throughout almost all of their area they furnish fewer rock exposures. The borough of the Bronx, although nearly as large as Manhattan and of similar formations, receives but a brief mention of four pages, and the borough of Richmond or Staten Island about four times as much. The evidences of glaciation in and about Greater New York are then taken up in the concluding pages.

The work contains a great deal of valuable record that will prove serviceable to engineers and contractors as well as to teachers and those with a popular interest in science. There

are historical details not easily attainable elsewhere. There is a valuable annotated list of minerals and an excellent bibliography. There is some need for the author to take greater care to attain a form of expression which may be grasped by those not necessarily widely read in the science. Unusual words such as femic, salic, crenitic and the like might best be omitted. In the stratigraphical table, page 5, if Carboniferous is replaced by Carbonic, why not use also Cambric, Siluric, Devonic and Cretacic. In the treatment of the stratigraphy of Manhattan Island, it is far simpler and clearer to take up the Fordham gneiss, the Inwood limestone and the Manhattan schist, than to treat merely of gneiss, limestone and schist, with minor varieties. If, when a fourth edition is called for, the author will place himself in the attitude of a reader not of profound attainments in geology and, thus grasping his or her point of view, will put the facts of the local strata in simple and clear language, and will add an index, a work already serviceable and of value will be made still more so.

J. F. Kemp

An Elementary Treatment of the Theory of Spinning Tops and Gyroscopic Motion. By Harold Crabtree. Pp. xii + 140. New York, Longmans, Green & Co. 1909.

This is a very satisfactory book for one who wishes to gain a clear understanding of gyroscopic action. It contains a good discussion of Schlick's method of steadying vessels at sea and of Brennan's gyroscopic mechanism for balancing a monorail car.

The introductory chapter describes a number of curious and interesting forms of tops and gyroscopes. Chapter I. discusses rotation about a fixed axis, Chapter II. discusses precession and Chapter III. is a discussion of the phenomena described in the introductory chapter.

The starting of precession and gyroscope oscillations are discussed in Chapter IV., and the remainder of the book, Chapters V., VI., VII., VIII. and IX., discuss the more elaborate aspects of the theory of gyroscopic action.

The curious behavior of the stone implement known as the celt which is described on pages 7 and 54 may be observed with an ordinary pocket-knife with a rounded back. When such a knife is twirled on a smooth table the reaction of the table due to its vibratory motion causes its direction of spin to be reversed and if the knife is set rocking about a horizontal axis the reaction of the table due to the vibratory motion produces a slight spin about a vertical axis.

Altogether the book is a welcome and valuable addition to the literature of rotatory motion.

W. S. Franklin

SPECIAL ARTICLES

A SIMPLE CLOUD APPARATUS

The celebrated experiment on the production of clouds by C. T. R. Wilson forms an instructive lecture table demonstration. This need not necessarily be a difficult experiment. It is common observation that clouds of greater or less density are often seen upon the first few strokes of the pump when evacuating a vessel containing some moisture. The apparatus as Wilson constructed it was of necessity rather elaborate. That it may be of exceedingly simple and inexpensive construction and yet capable of giving quantitative results of a fair degree of accuracy is the object of this paper.

The apparatus consists of a glass bulb having two openings. To one, the larger, is attached a stiff rubber bulb, to the other a nipple for the introduction of the gases, etc., to be investigated. For qualitative results the glass vessel is blown in the form of a hooded bulb B, as shown in Fig. 1. This bulb should have a volume of about 75 c.c., while the hand bulb HB may be the stiff bulb that comes with an hydrometer syringe for testing electrolytes. The volume of this bulb should be about 250 c.c. The nipple n is closed by a rubber tube and a screw pinch-cock at p. It is well to insert a short glass tube extension beyond p. To operate, draw into the bulb B two or three cubic centimeters of water. This will be caught by the annulus or trough in B, thus keeping the gas in the bulb in contact with

water and hence more or less completely saturated. Close pinch-cock at p firmly. Now by compressing HB moderately and then releasing suddenly a dense cloud, in general, will be formed in B.[1] Repeated compressions and expansions will bring down clouds of rapidly diminishing densities. The bulb B will be

P

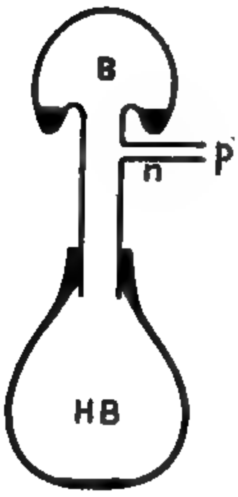

Fig. 1.

Fig. 2.

freed of dust particles by about the tenth expansion—depending upon the dustiness of the air originally drawn into the apparatus. Having freed the condensing chamber of dust particles, a dense cloud can again be formed by compressing the bulb firmly and then releasing. In this instance the expansion—*i. e.*, the ratio of the final to the initial volume of the gas—is greater than the critical value which for dust-free air is about 1.30.

The apparatus is now ready for the performance of a number of interesting and striking experiments. The formation of a single drop in the expansion chamber is not an uncommon sight. As is well known when the drops are few they are of large size and fall rapidly, while dense clouds formed in dust-laden air, or in dust-free air exposed to an ionizing agent, are composed of small drops, exhibit color effects and often may be quite opaque. This cloud settles slowly. The effect of dust is shown in a marked way by drawing into B a whiff of air laden with chalk dust. An exceedingly opaque cloud is obtained by presenting the nipple n to a burning match and drawing in some of the particles of carbon. It requires some twenty or thirty expansions to free the bulb of these particles. Dense clouds are formed by drawing in the gases through which an electric discharge is passing. The ionized air from the active side of a Roentgen ray bulb gives a marked effect. These cloud effects can be projected readily on a screen.

TABLE I

Critical Expansion in Dust-free Air

Zero	Upper Reading	Ratio	Cloud Effect
65	55	1.18	None.
65	54	1.20	None.
65	53	1.22	None.
65	52	1.25	None.
65	51	1.27	None.
65	50	1.30	A few dozen drops.
65	49	1.33	A dense cloud.
65	48	1.35	The same.
65	47	1.38	Very dense.

For quantitative results the apparatus is modified slightly. The trough in B may be omitted. The tube T should be 20 to 25 cm. long and graduated in cubic centimeters as shown in Fig. 2. The hand bulb HB and the tube T are filled with water to some convenient zero on the graduation. To operate, compress HB sufficiently to give the desired ratio on expansion. The free water column acts as an index and its proximity to B insures saturation. It is imperative that the walls of HB be of double or treble strength, otherwise the bulb on release will expand beyond the set zero. For individual observation the bulb B

[1] J. J. Thomson's "Conduction of Electricity through Gases," p. 167.

should be placed in front of a dead black screen and illuminated by a shielded lamp. A reading glass will aid considerably in observing the formation of the drops.

First determine the critical ratio, *i. e.*, the expansion at which drops just begin to form in dust-free air. Now produce expansions of gradually increasing amounts and note the cloud effects. A typical series is given in Table I.

As Thomson pointed out, after once drops have been formed in dust-free air they will form for some time after for expansions less than the critical value. Hence before another series is taken the bulb *HB* should be worked for moderate expansions to free the bulb *B* of nuclei. In Table II. are recorded two observations taken from each of ten different series similar to that given in Table I. The first observation, the critical expansion, is when drops first appeared, and the second is the next succeeding observation. This is recorded in the table to show how rapidly, yet uniformly, the drops increase by a slight increase in the expansion.

TABLE II

Critical Expansion in Dust-free Air

Tube	Zero	Upper Reading	Ratio	Cloud Effects
1	76	58	1.31*	A few large drops.
		57	1.33	A few hundred.
1	75	57	1.31*	Quite a cloud—large drops.
		56.5	1.33	A dense cloud.
1	76	58	1.31*	Just a few drops.
		57.5	1.32	About 50 drops.
2	65	50	1.30*	A few dozen drops.
		49	1.33	A dense cloud.
1	71	54	1.31*	A few dozen drops.
		53	1.34	A dense cloud.
2	65	50	1.30*	A few dozen.
		49.5	1.31	A dense cloud.
1	77	58.5	1.32*	A few drops.
		58	1.33	A few hundred.
1	77	58	1.33*	A few dozen.
		57.5	1.34	A few hundred.
1	77	58.5	1.32*	A few drops.
		58	1.33	A few hundred.
1	77	58.5	1.32*	A few drops.
		58	1.33	A few hundred.

Average of those marked (*) 1.31.

The average value of the critical ratio is 1.31. It should be noticed that the greatest variation from this mean is only 1.5 per cent.—a rather close agreement when we consider that the observations were made with two different tubes, and also that they extended over three or four weeks.

It was shown by Wilson that an ionizing agent is an important factor in the formation of drops in dust-free air. Various agencies, such as light from an incandescent lamp filament, the radiation from radium, the Roentgen rays, etc., were tried, each showing a decided effect. On placing a small glass capsule containing 10 milligrams of radium bromide of 200,000 activity within the bulb *B* a mean value of 1.27 was obtained for the expansion necessary to form drops. Care was taken to free the expansion chamber of dust particles, also to correct for the change in volume caused by the introduction of the small glass tube containing the radium. Again, with this simple apparatus it is not difficult to compare quantitatively the electrification when air is agitated with pure water, with a saturated common salt solution, and with mercury. The effects were all quite marked and the values obtained for the expansions could be repeated consistently at will.

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SYSTEM OF BASKETRY TECHNIC

ONLY in recent years have anthropologists interested themselves so generally in the industrial arts of primitive peoples. With this awakening interest has come the appreciation of the prominent place occupied by the cruder forms of weaving—namely, basketry—in the domestic economy of these simple households. It has assisted in the sheltering, the clothing and the feeding of tribes in many parts of the world. This wide distribution of locality, as well as that of usefulness, enables one to better understand the multiplicity of technics which are constructed of materials from so many climes, and in a manner to fit such a diversity of use. With the aggregation of

technics comes the necessity of uniformity in classification and terminology—that confusion may be avoided, and investigations be so recorded as to make possible scientific deductions, relationships of technics—and possibly of peoples.

The accompanying key to basketry, though in condensed form, is presented here with the thought that it may prove as helpful to the ethnologist unfamiliar with the work, as it has to the writer in serious study of collections from many parts of the world. An enlarged issue, fully explained and amplified, will appear later.

Acknowledgment must be made to the two authors who have previously treated basketry classification—Otis T. Mason and J. Lehmann—whose works have made it possible to take a step in advance, and record in clearer and more definite form this key to the technic.

The classification recognizes three kinds of basketry—plaited, woven and coiled ware, the division being based upon their construction or building process, as the elements plait, weave and coil. The fundamental process of the three distinct technics is easily discerned upon slight examination.

Plaiting constructs a mat-like surface by means of active elements only, which move over and under each other in regular order. No passive foundation elements are incorporated, neither are new elements added after the completion of the base, as those already furnished continue to plait the body of the basket.

Weaving is known by its upright warps extending from base to upper edge, as the surface is constructed on these passive warps, crossed by an active binding element, or weft. Two types of weaving—checked and twilled wicker—are less easily recognized because of the equal size of the warp and weft, but even here the distinct weft element added at the base may be traced encircling the basket.

Coiling can easily be distinguished by the spiral movement of its elements. This consists either of an active element, or of a passive element bound down by an accompanying active element.

This key approaches Mason's classification nearest at types of weaving, although here there are differences. Mason entirely excludes plaiting as a basketry process, while his types of coiled ware are based upon the components of the internal element—the foundations. The composition of the inner element is the last consideration, and a later division than is shown on this condensed key.

KEY TO BASKETRY TECHNIC

I. *Plaiting of Crossed Active Elements*

A. Parallel elements in two directions.
  1. Over and under one ...... Checked Plaiting.
  2. Over and under more than one, Twilled Plaiting.
B. Parallel elements in more than two directions, Lattice Plaiting.

II. *Weaving of Active Across Passive Elements*[1]

A. Parallel warps in one direction.
  1. Weft interlaced .... Wicker Weave.
    a. Warps coarser than weft, Plain Wicker Weave.
    b. Warps of same size as weft.
      a'. Over and under one, Checked Wicker Weave.
      b'. Over and under more than one, Twilled Wicker Weave.
  2. Weft twined.
    a. Weft of two strands.
      a'. Over one warp .... Plain Twine Weave.
      b'. Over two warps . Twilled Twine Weave.
    b. Weft of three strands.
      a'. Plain weft .... Three-ply Twine Weave.
      b'. Braided weft, Braid Three-ply Twine Weave.
  3. Weft wrapped .... Wrapped Weave.
B. Parallel warps in more than one direction.
  1. Weft interlaced .... Lattice Wicker Weave.
  2. Weft twined.
    a. Warps oblique, Oblique Lattice Twine Weave.
    b. Warps vertical and horizontal, Vertical Lattice Twine Weave.
  3. Weft wrapped .... Lattice Wrapped Weave.

III. *Coiling of Active Element or of Active Along Passive Element*

A. Active element only.
  1. Weft spiral .... Spiral Lace Coil.
  2. Weft twisting .... Twisted Lace Coil.
  3. Weft interlacing ..... Interlaced Lace Coil.

[1] Active elements are weft. Passive elements warp.

4. Weft knotting .... Knotted Lace Coil.

B. Active and passive elements.

1. Weft spiral .... Twisted Coil.
2. Weft twisting .... Twisted Coil.
3. Weft interlacing .... Interlaced Coil.
4. Weft looping .... Looped Coil.

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American Museum of Natural History

FUSARIUM WILT OF CABBAGE

Wilt or "yellows" disease of cabbage, due to an undescribed species of *Fusarium*, has been known in this department for some years, as a trouble of minor importance, but it is now gaining such headway in some cabbage sections that active measures will have to be taken to combat it.

Some of the important symptoms are: retarded growth, wilting of the foliage, yellowing and dropping of the lower leaves. Later the upper leaves are affected and drop off, leaving the stem bare. In some cases one half of the leaf turns yellow while the other half retains its normal green color for a time. Microconidia are present in great numbers in the water-carrying vessels of the living plant. Soon after the death of the plant, pinkish masses composed of macroconidia form abundantly on the surface.

This disease was first observed by Dr. Erwin F. Smith in 1895. Experiments made by him in 1899 point to the soil as the source of infection. In 1900 Mr. W. A. Orton, of the U. S. Department of Agriculture, made field observations on the disease in South Carolina, and isolated the fungus, but did not carry on further work.

In April, 1908, the writer isolated the fungus from some material sent in from the south. During the past summer the disease has been reported from several states. In the kraut district of northern Ohio it has been very destructive.

Pot experiments were started in one of the greenhouses, to determine the parasitism of the fungus. After the cabbage plants had been growing in the pots for about ten days, pure cultures of the fungus were mixed into the soil, care being exercised not to injure the rootlets. In about three weeks some of the plants began to show symptoms of the disease. An examination of the plants a little later showed 83 per cent. of successful inoculations. None of the controls contracted the disease. The fungus was again recovered from one of the diseased plants, fresh soil was secured, young plants set out and inoculated as in the previous case with pure cultures of the *Fusarium* isolated from one of the previously inoculated plants. The greenhouse conditions for these later experiments were very unfavorable, but a fair percentage of the inoculations were successful. The controls did not contract the disease. This disease will be studied further.

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U. S. Department of Agriculture

THE SEPARATED BLASTOMERES OF CENTRIFUGED EGGS OF ARBACIA

In recent years embryologists have been attempting to find out the rôle in development played by the visible materials of the egg (pigment, yolk, oil, etc.); whether they are organ-forming materials or merely passive inclusions. By no means has a uniform conclusion been reached.

In the eggs of *Arbacia*, the experiments of Lyon and Morgan show that the visible substances, by means of the centrifuge, can be thrown into any part of the egg without affecting in any way the embryonic development up to the pluteus. The simple experiment which I wish to record adds further proof that the visible substances in this particular egg are not organ-forming materials. Driesch and Morgan have shown that the one half, one fourth, one eighth and one sixteenth blastomeres of the sea-urchin egg are capable of developing into normal but smaller plutei. Lyon further showed in the centrifuged eggs of *Arbacia* that the visible substances separate readily into four distinct layers and that the first cleavage is nearly always at right angles to the stratification, but some few are parallel to it. The purpose of my experiment was to take those centrifuged eggs in which the first division plane was parallel to the stratification, separate the first two blastomeres and see

whether they would develop into normal plutei.

The eggs were first centrifuged and then fertilized. About one minute after fertilization the membrane was shaken off and the eggs transferred to calcium-free sea-water (Herbst's formula). They were allowed to segment in the calcium-free sea-water and some of the eggs in which the first cleavage plane was parallel to the stratification were isolated. After the blastomeres had fallen apart, they were transferred to normal sea-water where they were permitted to develop. The two blastomeres thus produced differ in that one contains all the red pigment while the other one is perfectly clear and contains the whole of the oil cap. The exact distribution of the two middle layers is not easily made out. Both blastomeres produce normal plutei. The only visible difference in the two was that one contained the red pigment-spots; the other lacked them. FERNANDUS PAYNE

INDIANA UNIVERSITY

THE CONVOCATION WEEK MEETINGS OF SCIENTIFIC SOCIETIES

THE American Association for the Advancement of Science and the national scientific societies named below will meet at Boston, Mass., during convocation week, beginning on December 27, 1909.

American Association for the Advancement of Science.—Retiring president, Professor T. C. Chamberlin, University of Chicago; president, Dr. David Starr Jordan, of Stanford University; permanent secretary, Dr. L. O. Howard, Cosmos Club, Washington, D. C.; general secretary, Professor Dayton C. Miller, Case School of Applied Science, Cleveland, Ohio.

Local Executive Committee.—H. W. Tyler, chairman; Thomas Barbour, J. S. Kingsley, Edward R. Warren, John Warren, George W. Swett, secretary.

Section A, Mathematics and Astronomy.—Vice-president, Professor Ernest W. Brown, Yale University; secretary, Professor G. A. Miller, University of Illinois, Urbana, Illinois.

Section B, Physics.—Vice-president, Dr. Louis A. Bauer, Carnegie Institution, Washington, D. C.; secretary, Professor A. D. Cole, Vassar College, Poughkeepsie, N. Y.

Section C, Chemistry.—Vice-president, Professor William McPherson, Ohio State University; secretary, C. H. Herty, University of North Carolina, Chapel Hill, N. C.

Section D, Mechanical Science and Engineering.—Vice-president, Professor John F. Hayford, Northwestern University; secretary, G. W. Bissell, Michigan Agricultural College, East Lansing, Mich.

Section E, Geology and Geography.—Vice-president, Reginald W. Brock, Canadian Geological Survey; secretary, F. P. Gulliver, Norwich, Conn.

Section F, Zoology.—Vice-president, Professor William E. Ritter, La Jolla, Cal.; secretary, Professor Morris A. Bigelow, Columbia University, New York City.

Section G, Botany.—Vice-president, Professor David Penhallow, McGill University; secretary, Professor H. C. Cowles, University of Chicago, Chicago, Ill.

Section H, Anthropology.—Vice-president, Dr. W. H. Holmes, Bureau of American Ethnology; secretary, Dr. George Grant MacCurdy, Yale University, New Haven, Conn.

Section I, Social and Economic Science.—Vice-president, Byron W. Holt, 54 Broad St., New York City; secretary, Dr. John Franklin Crowell, 44 Broad St., New York City.

Section K, Physiology and Experimental Medicine.—Vice-president, Professor C. S. Minot, Harvard Medical School; secretary, Dr. Wm. J. Gies, College of Physicians and Surgeons, Columbia University, New York City.

Section L, Education.—Vice-president, Dean James E. Russell, Columbia University; secretary, Professor C. R. Mann, University of Chicago, Chicago, Ill.

The American Society of Naturalists.—December 29. President, Professor T. H. Morgan, Columbia University; secretary, Dr. H. McE. Knower, University of Toronto, Toronto, Can. *Central Branch.* President, Professor R. A. Harper, University of Wisconsin; secretary, Professor Thomas G. Lee, University of Minnesota, Minneapolis, Minn.

The American Mathematical Society.—December 28–30. President, Professor Maxime Bôcher, Harvard University; secretary, Professor F. N. Cole, 501 West 116th St., New York City.

American Federation of Teachers of the Mathematical and Natural Sciences.—December 27, 28. President, Professor H. W. Tyler, Massachusetts Institute of Technology; secretary, Professor C.

R. Mann, the University of Chicago, Chicago, Ill.

The American Physical Society.—President, Professor Henry Crew, Northwestern University; secretary, Professor Ernest Merritt, Cornell University, Ithaca, N. Y.

The American Chemical Society.—December 27–31. President, Dr. Willis R. Whitney, General Electric Company, Schenectady, N. Y.; secretary, Professor Charles L. Parsons, New Hampshire College, Durham, N. H.

The Geological Society of America.—December 29, 31. President, Dr. G. K. Gilbert, U. S. Geological Survey; secretary, Dr. E. O. Hovey, American Museum of Natural History, New York City.

The Association of American Geographers.—December 30–January 1. President, Professor W. M. Davis, Harvard University; secretary, Professor Albert P. Brigham, Colgate University, Hamilton, N. Y.

The American Society of Vertebrate Paleontologists.—December 27–29. President, Dr. J. C. Merriam, University of California; secretary, Dr. E. S. Riggs, Field Museum of Natural History, Chicago, Ill.

The American Society of Biological Chemists.—December 28–30. President, Professor Otto Folin, Harvard Medical School; secretary, Professor William J. Gies, 437 West 59th St., New York City.

The American Physiological Society.—December 28–30. President, Professor W. H. Howell, Johns Hopkins University; secretary, Dr. Reid Hunt, Hygienic Laboratory, 25th and E Sts., N. W., Washington, D. C.

The Association of American Anatomists.—December 28–30. President, Professor J. Playfair McMurrich, University of Toronto; secretary, Professor G. Carl Huber, 1330 Hill St., Ann Arbor, Mich.

The Society of American Bacteriologists.—December 28–30. President, Dr. J. J. Kinyoun, Washington, D. C.; secretary, Dr. Norman MacL. Harris, University of Chicago, Chicago, Ill.

The American Society of Zoologists.—Eastern Branch, December 28–30. President, Professor Herbert S. Jennings, Johns Hopkins University; secretary, Dr. Lorande Loss Woodruff, Yale University, New Haven, Conn.

The Entomological Society of America.—December 29, 30. President, Dr. Henry Skinner, Philadelphia, Pa.; secretary, J. Chester Bradley, Cornell University, Ithaca, N. Y.

The Association of Economic Entomologists.—December 28, 29. President, Professor W. E. Britton, Connecticut Agricultural College; secretary, A. F. Burgess, U. S. Department of Agriculture, Washington, D. C.

The Botanical Society of America.—December 28–31. President, Professor Roland Thaxter, Harvard University; secretary, Professor D. S. Johnson, Johns Hopkins University, Baltimore, Md.

American Nature Study Society.—January 1. President, Professor C. F. Hodge, Clark University; secretary, Professor M. A. Bigelow, Teachers College, Columbia University, New York City.

Sullivant Moss Society.—December 30. President, Professor Bruce Fink, Miami University, Oxford, O.; secretary, Mrs. Annie Morrill Smith, 78 Orange St., Brooklyn, N. Y.

Wild Flower Preservation Society.—President, Professor Chas. E. Bessey; secretary, Dr. Charles Louis Pollard, New Brighton, N. Y.

The American Psychological Association.—December 29–31. President, Professor Charles H. Judd, University of Chicago; secretary, Professor A. H. Pierce, Smith College, Northampton, Mass.

The American Anthropological Association.—December 27–January 1. President, Dr. W. H. Holmes, Bureau of Ethnology; secretary, Dr. Geo. Grant MacCurdy, Yale University, New Haven, Conn.

The American Folk-lore Society.—Week of December 30. President, Dr. John R. Swanton, Bureau of American Ethnology; acting secretary, Dr. R. B. Dixon, Peabody Museum, Cambridge, Mass.

Association of Mathematical Teachers in New England.—December 28. President, Charles A. Hobbs, Watertown, Mass.; secretary, George W. Evans, Charlestown High School, Boston, Mass.

Physics Teachers of Washington, D. C.—Meets in conjunction with American Federation of Teachers. President, W. A. Hedrick, McKinley High School, Washington, D. C.; secretary, Dr. Howard L. Hodgkins, George Washington University, Washington, D. C.

American Phytopathological Society.—December 28–30. President, Dr. L. R. Jones, University of Vermont; secretary, Dr. C. L. Shear, U. S. Department of Agriculture, Washington, D. C.

American Alpine Club.—December 30. Secretary, Dr. Henry G. Bryant, Room 806 Land Title Building, Philadelphia, Pa.

American Breeders' Association.—Meeting of Eugenics Committee. Secretary, Dr. Chas. B. Davenport, Cold Spring Harbor, N. Y.

SCIENCE

FRIDAY, DECEMBER 31, 1909

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

A GEOLOGIC FORECAST OF THE FUTURE OPPORTUNITIES OF OUR RACE [1]

To those organizations that are struggling with the presidential problem, from Central American republics to social clubs, one may cordially recommend the unique practise of this association, for the adroitness with which it makes the presidential office go twice as far as is usual, while at the same time it reduces the hazard of the association to the lowest terms. Near the close of an annual session a president is chosen and is at once permitted to enter upon the annual functions of the office by attaching his signature to certificates of membership, which it is assumed he is competent at once to do, but he does not enter upon any conspicuous or presentative functions so unpreparedly; the retiring president holds the stage for the succeeding year. At the next annual session, after a year of manual practise exercised on relays of certificates that come at close intervals, the incoming president is formally introduced to the association and assumes the chair. During this session he responds to addresses of welcome and presides over the general sessions of the association with as much grace and dignity as he may be able to command, but beyond this he has no specific occasion, nor does the association assume any responsibility, for anything that might betray scientific attainments or the possession of opinions. Near the close of the session, a new president is chosen, and the active president enters upon his career as retiring presi-

[1] Address of the president of the American Association for the Advancement of Science, Boston, December 27, 1909.

dent. At the end of the year he is thought to have retired so far that he may safely be permitted to say what he wishes on some subject of his choice without undue hazard to the association. This permits him to deliver himself with a large degree of freedom. If he shall say anything amiss, the burden thrown on the association is merely the reflection that at an earlier stage in the evolution of the association, now lapsing into dimness of memory, an unfortunate selection was made.

The established custom of occasions of this kind leads the association to expect that its retiring president will address it upon some theme connected with the field of his own work. I shall not altogether ignore this custom, but I have chosen a theme that is at once peculiarly humanistic and distinctly prophetic. Geology has not usually been regarded as in any special sense a humanistic science, much less a prophetic one. But it is just because it has not been so regarded and because I have fondly dreamed that it might become tributary in an eminent degree to humanistic problems and to a prophetic insight that I have chosen the theme assigned for the evening.

Ever since the race came to a virile state of intelligence, it has tried to peer into the future that it might guide itself by its foresight. Now and then it has prolonged its vision beyond mere temporary concerns and has endeavored to prophesy the end of the race and the destruction of the earth. At all stages the depth of its vision into the things before has been close akin to the length of its vision backward and to the depth of its insight into the things about it. The lamp of the past and the illumination of the present have been its light for the future. This must doubtless always be its true method, for only as the race sees far into the past, sees widely and deeply into the present, has it any firm basis for a confident prophecy of the future. Even in its early days, the race did not fail to note that—though this may not be so of the ultimate entities—the existing *forms* come into existence, live their day and pass away; why not, therefore, the race and the earth on which it dwells? Even as the race grows into its fuller maturity and the horizon of its vision is enlarged, there will doubtless still remain the conviction that there has been a beginning of the current order of things, and a like conviction that there will be an end. The enlargement of vision will only serve to bring into view an additional multitude of organisms and organizations that have come into form, endured for a time and passed away. Any future change in human forecasts is not likely to be one of method, but one of measure. Some of the features that have entered into former prophecies will no doubt disappear and perhaps new ones be added. The forecasts of pre-scientific times often made the doom of the earth hinge on some lapse in the conduct of man—made a physical disaster serve as a moral punishment. With a better knowledge of the moral law and of man's place in nature, this anthropic view will no doubt give place to a more consistent insight into the sequences of the moral and the physical worlds.

In the earlier days of the race the backward look was short and the putative origin of the race and of the earth was placed but a few thousand years in the past; in consonance with this, the forward look placed the end not far in the future. So too, as the beginning was made chaotic, the end was made cataclysmic.

The dawn of the earth sciences was followed by a new forecast, and as these sciences grew this underwent revisions and recasts. It was learned that the history of

the earth stretches back not merely for thousands but for millions and tens of millions of years; that the on-goings of the earth are actuated by energies too broad and deep and strong to be swerved in their course or brought to an end by the acts of those who dwell upon it; that the march of earth-history has a mighty tread not to be measured by the merits or lapses of even our favored race.

The trend of prophetic thought in the last century invites a closer review. The basis of forecast lay fundamentally in the mode of origin assigned the earth and in the general trend of its past history, especially the trend of those agencies that controlled the conditions of life on its surface. The solar system was thought to have had its origin in a gaseous or quasi-gaseous nebula. The earth, as a member of the solar system, partook of this origin, and was conceived to have been, at an early stage, itself a fiery, gaseous globe. It is not needful here to review the special hypotheses or pay honor to their great authors from Kant and Laplace to Lockyer and Darwin, for the sole feature that potentially shaped the history of the earth was the early gaseo-molten state in which they essentially concurred. An alternative was indeed offered in the suggestion that the earth might have grown up by the accretion of small bodies but it was then held by students of dynamics that such an origin was inconsistent with the symmetry of the system and the rotations of the planets, and so an origin in the gaseous or quasi-gaseous form was almost universally accepted, as by compulsion. Later, the gaseous earth, by cooling and condensing, was thought to pass into a molten sphere wrapt in a hot vaporous atmosphere. This atmosphere was vast because the conditions required it to contain all the water of the globe and all the volatile matters that have since entered into the waters and the body of the earth. At a later stage a crust was logically made to form over the molten sphere and the waters to condense upon it, swaddling the entire globe perhaps in a universal ocean. By further cooling, shrinkage and deformation, the waters were thought to be drawn into basins, the land to appear and the history of the stratigraphic record to begin. It is important to note that the main agency in this hypothetical history was loss of heat; and so, with consistent logic, loss of heat was made to lie at the bottom of the great events of the earth's subsequent history and, in the forecast, to be the chief cause of its doom. From a plethora of heat, of air and of ocean, putative loss followed loss in the past, and by prophecy loss is to follow loss in the future until emaciation, drought and frigidity mark the final state and the end of all life. As the body of the earth cooled and shrank and permitted penetration, the ocean was made to enter it and by union with its substance was thought to have been suffering loss in the long past and to be doomed to further losses yet to come. By a like union of the constituents of the air with the body of the earth, as time went on, the great smothering atmosphere of the primitive days was supposed to be brought down first to compatibility with marine life, later to the lower land life and still later to the higher air-breathing forms. Projected logically into the future, still further depletion of the vital constituents even to the verge of exhaustion, attended with pauperization and finally with extinction of life, entered into the forecast. With the gathering of the oceans more and more into the basins and their absorption into the body of the earth, with the persistent consumption of the atmosphere and with the progressive cooling of the whole, the moisture of the air was thought also to have grown less and less. At first a deep,

warm mantle of vapor and cloud hypothetically clothed the whole earth, and even half way down the geologic ages was thought to have enshrouded the globe and to have given warm, sultry climates to all latitudes. But this mantle at length was made to give place to rifted clouds and clearer skies, and later on to mild aridities followed at length by desert stages which are even now supposed to be creeping out persistently on the once fertile lands. Thus we reach our own times at a putative stage when heat and air and moisture are running low; thus the predestined end is foreshadowed in the not distant future.

The round conception of the history shaped it as a progress from excess to emaciation, a sliding down the scale; it made the life history but an episode intercurrent in the great decline from the too hot and the too much to the too cold and the too little.

The logic in all this is plausible. Starting with the hypothetical premises, the conclusions seem to follow. Variations of detail might well be found in the complexities of the case. Especially might sources of supply be assigned to offset waste and loss in some degree, but granting the premises the conclusion is not easily escaped. In point of fact the general conception dominated the geologic thought of the last century. Not only this, but in no small degree it gave direction to the interpretations and in some measure even influenced the observations of geologic phenomena well down to the close of the century and is far from obsolete to-day.

But logical and plausible as was this general conception of earth-history, it was hung, as you have not failed to notice, on the hypothesis of the genesis of the earth accepted. However logical, its logical strength was only that of the hypothesis on which it was hung. I say its *logical* strength advisedly, for outside the logic of the general concept there was always the appeal to the concrete evidences of the geologic record. This appeal was made, and was thought to be on the whole confirmatory. The strata of high latitudes were found to contain relics of life of tropical or sub-tropical types, not only in the early stages but well down toward recent times. Figs and magnolias grew in Greenland as late as the Tertiary period. Phenomena so striking gave deep hold to the logical scheme. Phenomena not so consonant with it were easily overlooked or lightly passed by as is our wont when too much impressed by what *must* be true. It is, however, a merit of modern science that it puts that which *is* to the front and that which logically *must be* in a secondary place. And so during the past century inconsonant data were gathered with the consonant. Most of the inconsonant facts were of the unobtrusive sort, but yet some of them were startling, were seemingly incredible, were indeed long doubted and only slowly gained credence. The accumulation of this inconsonant data gradually weakened the hold of the general logical concept and prepared the way for a reconsideration.

Meanwhile a serious source of doubt had arisen on the logical side, from the progress of physics. The older hypotheses of the origin of the earth had been framed before the kinetic theory of gases was evolved. After the kinetic view was accepted it was pointed out by Johnstone Stoney that the velocities of the molecules of the outer air place a limit to the volumes which planetary atmospheres may possess. When the test which this suggested was applied to the postulated atmospheres and voluminous gaseous states of the early earth, it gave rise to grave doubt as to the physical consistency of these conceptions.

Weakness also arose in another quarter. One of the main props of the gaseous or quasi-gaseous hypotheses was, as already remarked, the general conviction based on dynamical grounds that condensation from any other nebulous state than gaseous or quasi-gaseous would give revolutions and rotations to the planetary system at variance with those actually possessed. A re-examination, however, near the close of the century, developed grounds for the conviction that a gradual gathering in of matter from a scattered orbital state would give rotations and revolutions quite as well in accord with the facts formerly known and seemingly even better in accord with new facts recently brought to light.

Thus toward the close of the last century there arose from different quarters cogent reasons for a reconsideration of the prevailing general view, and with it a recast of the former forecast. Further scrutiny added new doubts to those that had previously arisen and in the end the verity of the older hypotheses of genesis was challenged and new conceptions based on orbital dynamics, in contrast to gaseous dynamics, were offered in their stead.

It is not appropriate for me to say that this challenge was successful, or that the older conceptions of the earth's origin are to be laid on the shelf. As an advocate of the method of multiple working hypotheses it belongs to me to beg of you to save and to use, so far as you can find use in them, all the hypotheses that seem to you to be capable of working at all. Much less would it be appropriate for me to affirm that any form of the newer conceptions is entitled to take the place of the older in your complete confidence. The final adjudication of genetic hypotheses can only come of long and patient trial by searching analysis, by scrutinizing logic and by application to the multitudinous phenomena which not only the earth, but the solar and stellar systems present. It is sufficient warrant for the present review, however, that not a few of the more incisive students of these things have been led to seriously reconsider the foundations of the hypotheses of earth-genesis that have been offered, old and new, and to examine with renewed care the interpretations and inferences that have been made to hang upon them. Whatever may be your personal leanings you will no doubt agree that it seems less laudable now to hang prophecies of the future upon hypotheses of genesis, than when certain of these hypotheses received the almost universal assent of those then best qualified to hold opinions respecting them.

It does not seem to be going too far, moreover, to say that whereas we seemed to be shut up to hypotheses of genesis that gave the earth a gaseo-molten state at the start, it now seems, to some students at least, possible that the earth inherited a quite different state from a slow growth from planetesimal or other accretions. If diverse views are thus permissible they offer alternative working conceptions and thus help to give freedom of interpretation while they stimulate observation on the critical phenomena. We may therefore be permitted first to review the states assigned the early earth by the competitive genesis offered and then the critical phenomena that bear upon the earth's future.

Quite in contrast with the older pictures of a primitive earth cooling from a gaseous state, the planetesimal hypothesis, which may be taken as representative of theories based on concentration from a dispersed orbital state, postulates a solid earth growing up slowly by accessions and becoming clothed gradually with an atmosphere and a hydrosphere. Each of the fundamental parts, the earth, the air and the water, is

made to grow up thus together from smaller to larger volumes, without necessarily attaining at any stage a very high temperature. The early sources of growth for the atmosphere and the ocean, though reduced in later time, continued to serve as sources of replenishment when the familiar agencies of loss came into play in the later ages. Thus, far from assigning at the start a vast atmospheric and oceanic supply, and assuming progressive depletion of this with the progress of time, the newer view starts with a minimum supply and rests on means of feeding which are held to run hand in hand with the sources of loss and to more or less completely compensate them in a varying way. The question of the future under this view is, therefore, not how long beyond the present day will the original supply last, but rather how long will the oscillating compensation of loss and supply remain effective? Or in other words, how long will the past degree of equilibrium between the opposing agencies keep the critical conditions within the limits required by life? This question turns us quite away from any serious dependence on the original states and centers attention on the geologic record and on the potency of agencies still in action. Are the chief agencies which have controlled life conditions for tens of millions of years past still in good working order and likely to continue effective for a long era yet to come, or do they show clear signs of declining power portending an early failure? Let us enter a little closer into the consideration of the specific factors on which life depends, though time will not permit us to go far.

The pre-scientific fear that the end of life will come by cataclysm is not yet obsolete, nor is it theoretically impossible, but violent agencies are among the least to be feared. Life might indeed be imagined to be in jeopardy from volcanic and seismic convulsions but they really offer no serious menace to life in general, and they appear never to have done so in the known ages. The deadliness of these boisterous catastrophies impresses itself unduly on the emotions. The real peril, if peril there be, lies in the deadly unbalancing of agencies of the quiet sort.

The conditions essential to the maintenance of the habitability of the earth are many, but the more critical factors either lie in the atmosphere itself or are intimately associated with it. The point of keenest interest is the narrowness of range to which these mobile factors are confined. The several constituents of the atmosphere might each or all easily be too scant or too abundant. In a peculiar sense is this true of the carbon dioxide which, though one of the least, is preeminently the decisive constituent of the atmosphere. A small proportion of carbon dioxide is essential to plant life and so to animal life, while a large proportion would be fatal to air-breathing animals. If the three or four hundredths of one per cent. now present were lost, all life would go with it; if it were increased to a few per cent., the higher life would be suppressed or radically changed. And yet, on the one hand, the theoretical sources of supply are abundant, while, on the other, the agencies of depletion are efficient and active. There is little escape from the conclusion that ever since the birth of air-breathing life, some 30,000,000 or 40,000,000 years ago, let us say, the interplay of these agencies of supply and depletion has been so balanced that neither fatal excess nor fatal deficiency has been permitted to cut short the history of the higher life.

The dangers of excess or deficiency of the other constituents of the air are indeed less narrow when named in percentages,

but they are scarcely less real in theoretic possibility.

The well-being of life is hemmed in between a suitable proportion of moisture in the air dependent on a competent area of water-surface to supply it, on the one hand, and a diluvial excess of water, on the other. Universal deluges and universal deserts would alike be disastrous. A few thousand feet more of water-depth or a few thousand feet less would alike seriously restrict the class of life to which we belong.

In even a more serious way the habitability of the earth is conditioned on a narrow range of mean temperature—a range, roundly speaking, of 100° Centigrade. This is scarcely 5 per cent. of the range of natural temperatures on the earth and a still smaller per cent. of the range of temperatures in the heavens. A few miles above us and a few miles below us, fatal temperatures prevail. It is profoundly significant that the thermal states of the narrow zone of life on the face of the earth should have been kept within so close variations as to permit the millions of species forming the great genealogical lines leading up from the primitive types to have perpetuated their lineages in unbroken continuity for such ages, while the prevalent temperatures a few miles above them or a few miles below them, as well as in space generally, would have been fatal. While the necessary heat is dependent on the sun, this control of temperature seems to have been intimately related to the atmosphere and is a further index of its specially critical functions.

To appreciate the full significance of the control of life conditions within these narrow limits when the possibilities were so free and so wide, there is need for some tangible index of the time, but there are at present no means for the close measure of the geologic ages, merely rough estimates of the order of magnitude. Life was far advanced when a readable record first began to be made; but yet since that record began, at least 100,000 feet of sediments—not to choose the largest estimates—have been laid down by the slow methods of wash from the land and lodgment in the basins. The estimate of the years thus represented has been put variously from 50,000,000 to 100,000,000, with indeed higher figures as well as lower. Merely to roughly scale the order of magnitude, and without pretense of accuracy, let us take the midway figure of 75,000,000 years as representative. Let this be divided into fifteen periods of 5,000,000 years each and these will roughly represent the technical "periods" of geologists. By this rough scale we may space out such of the great events as we need now note.

Slight and changeable excesses of evaporation over precipitation and the reverse prevail widely, but only intense and persistent aridity gives rise to thick deposits of salt, gypsum and other evaporation products over large areas—with perhaps some exceptions—for in nearly all large natural basins the area that collects rainfall is notably larger than the closed basin within it that alone can retain water for continuous evaporation. It is therefore fairly safe to infer clear skies and pronounced aridity when beds of salt and gypsum occur over large areas, especially if accompanied by appropriate physical characters and by such types of life only as tolerate high salinity, or show pauperization, or by a total absence of life.

Now extensive deposits of salt and gypsum are found in the Salt Range of India, in strata of the Cambrian period, the earliest of the fifteen that make up our rough scale of 75,000,000 years. Because these lie so near the beginning of the geologic record they afford a singularly in-

structive insight into the conditions of the atmosphere well back toward its primitive state. They challenge at once the view that in those early ages the earth was swaddled by a dense vaporous atmosphere from pole to pole; for under such a vaporous mantle a great desert tract in India would be scarcely credible.

If we come forward in time two periods, to the deposits of the Silurian stage, we find that underlying the basin of the St. Lawrence in New York and westward there stretch great sheets of salt and gypsum, many thousand square miles in extent. These beds are accompanied by complete barrenness of life in some parts, by pauperization of life in other parts, by selections of life according to tolerance of salinity in still other parts, and by harmonious physical characters, all of which combine to add strength to the interpretation. All these imply a degree of aridity approaching desert conditions in what is now the well-watered region of our Great Lakes. These signal facts join those of the Salt Range of India of earlier date in challenging the former conception of a universal envelope of vapor and cloud in all those early times.

In the next period there are formations that have been interpreted as implying desert conditions, but perhaps on less firm grounds, and we pass on to certain stages in the sub-Carboniferous period next following, wherein beds of salt and gypsum are found in Montana, Michigan, Nova Scotia and Australia, which imply like climatic conditions. If we pass on to the Permian and Triassic periods, near the middle of the geologic series, beds of salt and gypsum are phenomenally prevalent on both the eastern and western continents, reaching through surprising ranges of latitude. The relative paucity, as well as the peculiar characteristics of the life of those times, seems equally to imply vicissitudes of climate in which scant atmospheric moisture was a dominant feature. There seems no tenable way to interpret these remarkable facts of the middle periods except by assuming an even greater prevalence of aridity than obtains at the present time. So, at times in the later periods, but at times only, the stratigraphic record implies atmospheres as arid as that of to-day, not everywhere, indeed, but in notable areas and in certain horizons.

These and other significant facts of consonant import form one group of phenomena.

If, on the other hand, the record be searched for facts of opposite import, they will come easily to hand. Starting near the beginning of the record, it is even more easy to find stages abounding in evidences of prevailing humidity, of great uniformity of climate and of most congenial life-conditions reaching through wide ranges of latitude. If we rested on this selection alone, the old view would be abundantly sustained; but the strata bearing evidences of aridity lie between these. Combining the two sets of facts, the conception seems to force itself upon us that from the very earliest stages of the distinct life-record onward, there have been times and places of pronounced aridity much as now, or even more intense, while at other times, intervening between these, more humid and uniform conditions prevailed.

This conception grows in strength as we turn from atmospheric states to prevailing temperatures. The body of scientific men have rarely been more reluctant to accept any interpretation of geologic phenomena than that of recent general glaciation on the lowlands of Europe and America in mid-latitudes when that view was first advanced by Louis Agassiz. With the conception of former pervasive warmth then

prevalent, it seemed beyond belief that great sheets of ice could have crept over large portions of the habitable parts of Europe and North America some thousands or tens of thousands of years ago. Belief in this was made easier, however, by the view also then prevalent that the earth had been greatly cooled in the progress of the ages, that the atmosphere had been much depleted by the formation of coal, of carbonates and of oxides, that the ocean had been reduced by hydration and entrance into the earth, and that thus a stage had been reached that made possible an epoch of depressed temperature and of glaciation. The ice age, thus theoretically associated, came to be widely regarded as but the first stage in a series of secular winters destined to lead on to the total refrigeration of the earth. This view was abetted by the theory of a cooling sun. The depleting and the cooling processes were regarded as inevitably progressive, and the final doom of the earth as thus foreshadowed in the near future, geologically speaking.

But opinion was scarcely more than adjusted to this view when the geologists of Australia, of India and of South Africa, severally and independently, and later those of South America presented evidences of former glaciation over extensive areas in those low latitudes. The typical marks of glaciation were indeed traced even up to and a little across the tropical circles from the south, in Australia, and from the north, in India. Moreover, all these were reported from strata of Permian or late Carboniferous times, *i. e.*, from the sixth or seventh of the technical "periods." For a score of years the body of geologists not in immediate contact with the evidence itself, doubted the interpretation, but the growing evidence grew at length to be utterly irrefutable. There seems no rational escape from the conclusion that mantles of ice covered large areas in the peninsula of India, in Australia, in the southern part of Africa, and in South America, close upon the borders of the tropics, at a time roundly half way back to the beginning of the readable record of life.

On the basis of similar evidence Strahan and Reusch have announced glacial beds in Norway at a horizon much lower but not closely determinate. Willis and Blackwelder have described glacial deposits of early Cambrian age in the valley of the Yangtze in China in latitudes as low as 31°. Howchin and David have described glacial formations of similar age in Australia. In the last two cases the glacial beds lie below the strata that bear the Cambrian trilobites; in other words, they lie at the very bottom of the fossil-bearing sediments, fifteen periods back, or 75,000,000 years ago on our rough scale. Professor Coleman has offered what he deems good evidence of glaciation much farther back at the base of the Huronian in Canada, but some skepticism as to its verity has yet to be overcome.

Even more pointedly than the epochs of aridity, do these early epochs of glaciation seem incompatible with the view of a hot earth universally wrapt in a vaporous mantle in early times. They favor the alternative view of merely temporary localized intensifications of climate which life was able repeatedly to survive. This seems to warrant the belief that life may survive similar intensifications again and again in the future.

At present polar and alpine glaciation are contemporaneous with aridity. There are reasons for thinking that the past glaciations and aridities were in some similar way correlated and that they cooperated to give vicissitude to the climates of certain geologic epochs. The known epochs of glaciation, however, are fewer than those of aridity.

On the other hand, at several stages, as already noted, abundant life, bearing all the evidences of a warm-temperate or sub-tropical character, flourished in high latitudes. In Greenland, Spitzbergen and other Arctic islands, are found the relics of life not known to be able to live except under conditions of genial warmth. These imply former sub-tropical conditions where now only frigidity reigns.

In the light of these contrasted climatic states of aridity and glaciation, on the one hand, and of uniformity and geniality in high latitudes on the other, intervening between one another, we seem now forced to the conception of profound climatic alternations extending over the whole stretch of known geologic time. Concurrent with these alternations there may perhaps have been variations in the constitution, as there certainly were in the condition, of the atmosphere.

If we turn to the relations of the waters and the land, an analogous oscillating history presents itself. This was possibly connected causally with the climatic oscillations. At no time in the history recorded by clear geologic testimony is there proof of the absence of land, and certainly at no time is there a hint of the absence of an ocean, whatever theoretic views may be held of the earliest unknown stages.

The progress of inquiry seems to force the conviction that the land area in the earliest stages of good record was quite comparable to that of the present time, both in its extent and in its limitations. Following down the history, the land area seems at certain times to have been larger than now, while at other times it was smaller. There appears to have been an unceasing contest between the agencies that made for the extension of the land and the agencies that made for the extension of the sea. While each gained temporarily on the other, complete victory never rested with either. From near the beginning of the readable record there appears to have been an unbroken continuity of land life, and from a like early stage, an unbroken continuity of marine life. Probably the history of both goes back unbroken into the undeciphered eras which precede the readable record, and no one to-day can safely affirm the precedence of either over the other, either in time or in genesis, whatever his theoretic leanings may be.

Among the agencies that may be assigned for the extension of the land are those that deform the body of the earth, deepening its basins and drawing off the waters, while other portions are protruded and give renewed relief and extent to the land. Among the agencies that make for the extension of the sea are the girdling of the waves about the borders of the land and the decay and wash of the land surface which is thus brought low at length and covered by the advancing waters. If the deformation of the earth-body were held in abeyance for an indefinite time, the lowering of the land, the filling of the basins, and the spreading of the sea would submerge the entire land surface and bring an end to all land life. Great progress in such sea-transgressions appears to have been made again and again, until perhaps half the land was submerged, but before land life was entirely cut off or even very seriously threatened, a regenerative movement in the body of the earth intervened, the land was again extended and the sea again restricted. Here then, also, there has been a reciprocal movement which, while it has brought alternate expansions of land life and of sea life, has, notwithstanding, permitted the preservation of both, and thus maintained the continuity of the two great divisions of life.

It appears, thus, that in each of the great groups of terrestrial conditions upon

which life is dependent, there has been, through the known ages, vast as they are, an oscillatory movement which has brought profound changes again and again but has never permitted any of the disasters threatened in these movements to go far enough to compass the universal extinction of life. These reciprocal movements appear to be dependent upon a balancing of the action of agencies that is scarcely less than a law of equilibrium. It is not too much to regard this as a regulative system. A clear insight into the agencies of this regulative system is rather a task of the future than an attainment of the present, and I can only offer tentative hints of what may prove to be its main factors and beg of you to accept them with due reserve.

The preservation of the land against the incessant encroachments of the waters seems probably due to a periodic deformation of the earth-body dependent on internal dynamics not yet well understood, at least not yet demonstrated to general satisfaction. The body of the earth feeds its atmosphere through volcanic and other means. How far this is merely a return of what has been absorbed earlier it is not prudent here to say, as opinion is not harmonious on this, and the evidence is as yet uncertain. Much depends on the constitution of the earth's interior and that in turn hinges on its mode of origin. Perhaps it will be agreed generally that feeding from the interior is one of the sources of supply which offsets the depletion of the atmosphere caused by its union with earth substance, in short that the earth-body gives out as well as takes in atmospheric material. Important or unimportant as this may be, it is not apparent that there is in it any automatic balancing suited to control the delicate adjustments requisite for continuity of life. The ocean acts as an important regulator by alternately absorbing and giving out the atmospheric gases as required by the state of equilibrium between the water and the air. This action is automatic but has its limitations and peculiarities and does not seem wholly adequate. If we are able to name such an adequate automatic action at all at present, it probably lies in the molecular activities of the terrestrial and solar atmospheres and in the relations of these to the gravitative powers of the earth and the sun.

If analysis of the molecular action of the outer atmosphere be pushed to its logical conclusions, it leads to the conception of supplementary atmospheres, in part orbital, filling, in their attenuated way, the whole sphere of the earth's gravitative control. A similar study of the sun's atmosphere suggests a similar supplementary extension and this extended portion surrounds and embraces the earth's atmosphere. Under the laws of molecular activity these two atmospheres must be interchanging molecules at rates dependent on the conditions of equilibrium between them. It is reasonable that an excess in the earth's atmosphere should cause it to feed out into the sun's sphere of control more than it receives, and that a deficiency in the earth's atmosphere should cause more feeding in from the sun's supplementary atmospheres than the earth gives out. If this conception be true and be efficient, the maintenance of the delicate atmospheric conditions required for the continuity of life is automatically secured. The failure of our atmospheric supply is thus made to hang, not simply on the losses and gains at the earth's surface, but on the solar interchange and hence on the solar endurance.

The sun is giving forth daily prodigious measures of energy. The endurance of the sun is not, however, merely a question of unrequited loss, for it gains energy and

substance daily as well as loses, but so far as present knowledge goes, its gain is greatly inferior to its loss. So long as the heat of the sun was supposed to be dependent on ordinary chemical changes, or on the fall of meteorites, or on self-contraction, an activity adequate for terrestrial life could only be estimated at a few million years. But recent discoveries in radio-activity have revealed sources of energy of an extremely high order. In the light of these the forecast of the sun's power to energize the activities of the atmosphere dependent on it and to warm the earth is raised to an indeterminate order of magnitude.

If we may thus find grounds for a complacent forecast in reciprocal actions on the earth and in reciprocities between the earth and the sun, are we free from impending dangers in the heavens without?

Present knowledge points to one tangible possibility of disaster; collision with some celestial body, or close approach to some sun or other great mass, large enough to bring disaster by its disturbing or disruptive effects. Within the solar system, the harmonies of movement already established are such as to give assurance against mutual disaster for incalculable ages. Comets pursue courses that might, theoretically at least, bring about collision, but do not appear usually to possess masses sufficient to work complete disaster to the life of the earth even should collision occur, whatever local disaster might follow at the point of impact. The motions of the stars, however, lie in diverse directions, and collisions and close approaches between them are theoretically possible, if not probable, or even inevitable. There are also in the heavens nebulæ and other forms of scattered matter, and doubtless also dark bodies, which may likewise offer possibilities of collision. The appearance of new stars flashing out suddenly and then gradually dying away suggests the actual occurrence of such events. It has been even conceived that the close approach of suns is one of the regenerative processes by which old planetary systems are dispersed and new systems are brought into being. One phase of the planetesimal hypothesis is built on this conception and postulates the close approach of some massive body to our ancestral sun as the source of dispersion of a possible older planetary system and the generation of the nebulous orbital condition out of which our present system grew. However this may be, it must be conceded that in collision and close approach lie possibilities, if not probabilities, of ultimate disaster to the solar system and to our earth. But here, as before, the vital question lies in the time element. How imminent is this liability? The distances between stars are so enormous that, though they move diversely, the contingencies of collision or disastrous approach are remote. Nothing but rough computations based on assumptions can be made, but these make disaster to a given sun or system fall on the average only once in billions of years. There is no star whose nearness to us, or whose direction of motion is such as to threaten the earth at any specific period in the future. There is only the general theoretical possibility or probability. While, therefore, there is to be, with little doubt, an end to the earth as a planet, and while perhaps previous to that end conditions inhospitable to life may be reached, the forecast of these contingencies places the event in the indeterminate future. The geologic analogies give fair ground for anticipating conditions congenial to life for millions or tens of millions of years to come, not to urge the even larger possibilities.

But congeniality of conditions does not

ensure actual realization. There arise at once questions of biological adaptation, of vital tenacity and of purposeful action. Appeal to the record of the animal races reveals in some cases a marvelous endurance, in others the briefest of records, while the majority fall between the extremes. Many families persisted for millions of years. A long career for man may not therefore be denied on historical grounds, neither can it be assured; it is an individual race problem; it is a special case of the problem of the races in the largest sense of the phrase.

But into the problem of human endurance two new factors have entered, the power of definite moral purpose and the resources of research. No previous race has shown clear evidence that it was guided by moral purpose in seeking distant ends. In man such moral purpose has risen to distinctness. As it grows, beyond question it will count in the perpetuity of the race. No doubt it will come to weigh more and more as the resources of destructive pleasure, on the one hand, and of altruistic rectitude on the other are increased by human ingenuity. It will become more critical as the growing multiplicity of the race brings upon it, in increasing stress, the distinctive humanistic phases of the struggle for existence now dimly foreshadowed. It will, beyond question, be more fully realized as the survival of the fittest shall render its verdict on what is good and what is evil in this realm of the moral world.

But to be most efficient, moral purpose needs to be conjoined with the highest intelligence, and herein lies the function of research. None of the earlier races made systematic inquiry into the conditions of life and sought thereby to extend their careers. What can research do for the extension of the career of man? We are witnesses of what it is beginning to do in rendering the forces of nature subservient to man's control and in giving him command over the maladies of which he has long been the victim. Can it master the secrets of vital endurance, the mysteries of heredity and all the fundamental physiological processes that condition the longevity of the race? The answer must be left to the future, but I take no risk in affirming that when ethics and research join hands in a broad and earnest endeavor to compass the highest development and the greatest longevity of the race the era of humanity will really have begun.

T. C. Chamberlin

THE THESIS OF MODERN LOGISTIC[1]

I have chosen to report upon this subject because it is one in which I have found no little interest in recent years; because the thesis in question represents one among the greatest of all the triumphs of critical thought; because it possesses such high and permanent importance as belongs to intellectual activity above the levels of workaday life; because it is sufficiently new, timely and general in its appeal; and finally because, whilst it has come to be everywhere a topic of much philosophic and scientific allusion, but relatively few, it seems, have been at the pains to ascertain what the thesis precisely is.

To tell what it is, to render it intelligible not merely to astronomers and mathematicians but also to that larger class of educated folk who, as their primary interests lie elsewhere, are not accustomed to thinking much about the fundamental subtleties of logic and mathematics—*that* is one of the two aims of this address; the other one being to present, in so far as time will

[1] Address of the vice-president and chairman of Section A—Mathematics and Astronomy—American Association for the Advancement of Science, Boston, 1909.

allow, the more salient among the facts by which the thesis is supported.

It is no part of my purpose to treat the matter historically. As, however, the thesis in question is the goal and culmination of two originally independent but closely related and finally convergent movements of modern thought, I can not refrain from saying a brief preliminary word regarding each of them. They may be characteristically designated as the critico-mathematical movement and the logistical movement.

The distinctively critical spirit is not a new manifestation in mathematics. The age of Euclid was a critical age. And just now, thanks to the superb edition of the "Elements" by Dr. Heath with its wonderful richness of bibliographic citation, quotation and critical commentary, one is enabled to understand better than ever before how very fine and penetrating in fundamental questions of geometry and of logic was the thought of the age that produced the Alexandrine classic—the age, I say, for the "Elements" is to be attributed not less to the age of Euclid than to Euclid the man. But it is not of antiquity that I wish to speak. I refer to the critical movement in *modern* mathematics—to the demand for precision of concept, to the process of logical rigorization, to the sense and the craving for perfection of intellectual and scientific form, in a word, to that spirit of creative criticism which, following close upon the great Eulerian and pre-Eulerian period of discovery, manifesting itself already in the works of Gauss and Lagrange, finding powerful agencies in the analytic genius of Cauchy and Bolzano, in the geometric genius of Lobachevski and Bolyai, waxed in intensity throughout the lapsing decades of the nineteenth century, at length pervading the entire realm of mathematics like a refining and purifying fire. The result of this critical movement, thus originating in mathematics and conducted by mathematicians, was, not indeed the grounding of mathematics itself, regarded as a unitary science, but the grounding rather, upon distinct bases of postulated mathematical notions and propositions, of various great *branches* of the science; in witness whereof—to cite but one example—behold the theory of the real variable as founded by Weierstrass upon the familiar theory of the cardinal numbers assumed as certain, primordial and fundamental.

Such bases, however, were destined to appear, in the light of modern researches in another field or in what seemed at all events another, namely, the field of logic, not as constituting the foundation either of mathematics or of any of its branches but as genuine components of the superstructure. For it has ever been the faith of the logician that there are a few ideas in terms of which all definable ideas admit of immediate or mediate definition and a few propositions upon which as a basis or from which as a body of premises all demonstrable propositions admit of proof or deduction; and it has ever been the chief of the logician's problems to discover such a system of primitive concepts and propositions. It is in nothing less than a closely approximate solution of that hoary problem that modern investigations in logic have culminated. As every one knows, the conception of logic as an autonomous science is nothing new. Among the very greatest contributions of antiquity to human knowledge is the "Logic" of Aristotle. As a scientific achievement it is comparable to the "Elements" of Euclid—comparable to it also in another respect, namely, that it was not significantly improved upon for nearly two thousand years. Though always indispensable as an instrument of thought, yet logic, regarded as a science, remained stationary for so long a time, showing no

token of life, that it came to be thought of as a thing that is dead. And I suspect that even to-day there may be found scientific men of eminence who are not aware of the fact that in our time logic, as a field of research, affords a spectacle of teeming activity quite as intense as may be witnessed in physics, for example, or in astronomy or biology—men, it may be, who have yet to learn that, owing to modern logistic research, it would be as radical an error to identify the modern significance of the term logic with that of the Aristotelian system as to identify the modern meaning of the term geometry with that of Euclid's "Elements" or to identify modern jurisprudence with the code of Lycurgus or the "Pandects" of Justinian. By the logistical movement I mean the movement that began—somewhat prematurely, however, as the event was destined to show—in the logical speculations and investigations of Jungius (1587–1657), Leibniz (1646–1716) and Lambert (1728–1777); awaited the powerful impulse imparted by Boole's symbolical "Investigation of the Laws of Thought" (1854); and, under the leadership of C. S. Peirce in our own country, of Schröder in Germany, of Peano and his numerous collaborators in Italy, of Couturat, brilliant expounder and advocate of the subject in France, and of Russell, Whitehead and McColl in England, has at length produced that imposing body of doctrine now known throughout the scientific portions of the world under the characteristic name of symbolic logic.

In its present form and state of development this science is constituted of three distinct but interconnected branches: the logic of classes, which, though it corresponds to the traditional system of Aristotle, is far from being identical with it; the logic of propositions; and the logic of relations, which was originated by Charles S. Peirce, was much elaborated, refined and clarified by Schröder in the third volume of his "Vorlesungen über die Algebra der Logik," 1895, but owes its present form and conception mainly to the various contributions of Bertrand Russell in recent volumes of the *Revue des Mathématiques* (formerly the *Revista di Matematica*) and elsewhere.

For the purpose in hand the thing to be noted is the discovery of the fact that for the *notional basis* of the triple organon it was necessary and *sufficient* to assume, without definition, a very few notions—called the primitive ideas, or constants, of logic—in order that in terms of them all other notions entering logic should be definable; and that it was necessary and sufficient, for the *propositional basis*, to assume, without proof, a somewhat larger yet very small number of propositions—called the primitive propositions, or the premises, of logic—in order that by means of them all other propositions of the science should be capable of demonstration. This is not all, however; for it has been found—and here we encounter the *thesis of modern logistic*, the common culmination and result of the two movements hitherto sketched, and so a joint achievement of the logician and the mathematician, though hardly foreseen by either of them—it has been found, I say, that the basis of logic is the basis of mathematics also—that, in other words, given the primitives of logic, mathematics requires none of its own but that in terms of the logical primitives all mathematical ideas and all mathematical propositions admit respectively of precise definition and of rigorous demonstration. Accordingly, if a scientific edifice may properly be regarded as consisting of both foundation and superstructure, it becomes evident, the thesis once established, that, instead of logic and mathematics being, as hitherto supposed, radically distinct sciences, the latter is strictly

the outgrowth and prolongation of the former, and that the twain are one as the branches and upper stem of a tree are continuous with the lower stem and the roots.

To any one who knows something of the immensity of modern mathematics, something of the continent of doctrine that the term connotes, something of the countless variety and the infinite complexity of the ideas and propositions that compose the body and constitution of the science, the simple thesis in question is really astounding. And one demands that the thesis be explicated in terms in order that one may know precisely and concretely in detail what it constates. What, we wish to be informed, *are* the logical primitives that, it is alleged, are capable, though so few, of supporting so great a burden? Before attempting to meet this demand, I beg to remind you of the fact that, given a logically coherent or autonomous body of propositions, it is always in some degree a matter of arbitrary choice, though probably never one of complete indifference which of the propositions are taken as fundamental and which as derivative—that is, which are assumed and which proved. In every case the choice is to be guided by considerations of expedience, of interest, or of economy, but seems never to be coerced by necessity or by "the nature of things." Questions of relative interest, however, and of relative expedience and economy are matters of judgment. Accordingly it is not a matter for surprise that several systems of logical primitives have been devised and submitted, differing any two of them in respect of one or more elements but agreeing all of them as to the adequacy of a small number of elements, and that among investigators in the field it remains a moot question which of the systems, if any one of them enjoys that distinction in comparison with the rest, is to be preferred.

The system that I shall present here is that which Russell has adopted in his great synthesis of modern logic and modern mathematics, "The Principles of Mathematics," and which with slight modifications has been so delightfully expounded by Couturat in his "Les Principes des Mathématiques" and his "Traité de Logistique." I have thought it best to gather together all the primitive elements of the three branches of logic for compact presentation in a single uninterrupted list under their appropriate headings, reserving commentary for a subsequent stage. Moreover, despite the somewhat forbidding appearance, at first glance, of logical symbolism, I have decided to present primitive propositions in symbolic form, employing for this purpose the symbolism of Peano slightly modified by selection from that of Schröder. Indeed this symbolism is not difficult to master; and if at first it seems a thing of so frightful mean that to be hated needs but to be seen, yet, seen often enough to become familiar with its face, we come first to endure, and then to embrace it as a convenient and potent means of clarity and economy alike of thought and of expression. It is a moot question which one, if indeed any one, of the three varieties of the logical calculus is primordial to the other two. As, however, discourse of any kind, whether about classes or about relations, would seem to be difficult if not impossible without propositions, I shall follow the leading of common sense and begin with

The Logic of Propositions.—In addition to the notions, truth and its negative, which, though they are constantly employed, seem neither to admit of effective definition nor to be strictly coordinate with any other indispensable notion, the primitive notions in propositional logic are

(1) Material Implication,

(2) Formal Implication.

And the primitive propositions are

(1) $p\supset q.\supset.p\supset q$,

(2) $p\supset q.\supset.p\supset p$,

(3) $p\supset q.\supset q\supset q$,

(4) If $p\supset q$ and if p be true, p may be dropped and q asserted,

(5) $p\supset p.q\supset q.\supset.pq\supset p$,

(6) $p\supset q.q\supset r.\supset.p\supset r$,

(7) $q\supset q.r\supset r.p\supset.q\supset r:\supset.pq\supset r$,

(8) $p\supset p.q\supset r.pq\supset r:\supset:p\supset.q\supset r$,

(9) $p\supset q.p\supset r.\supset.p\supset qr$,

(10) $p\supset p.q\supset q\supset:(p\supset q)\supset p.\supset p$,

in which, as elsewhere, p, q and r denote propositions, $\supset$ (inverse of the letter c) stands for the word *implies*, pq means "p and q," while the points or dots serve the double use of denoting the word *and*, like the first dot in (5), or, like those in (1), playing the rôle of parentheses in indicating the relative ranks of the various parts of a formula. Thus, for example, (7) may be translated to read, the proposition "q implies q and r implies r and p implies that q implies r" implies the proposition "p and q together imply r"; or, in hypothetic form, if q implies q, and r implies r, and p implies that q implies r, then p and q together imply r.

The Logic of Classes.—The primitive notions in this calculus are

(1) Proportional Function, denoted by such symbols as $\phi(x)$, $\Psi(x)$, etc.,

(2) The Relation (denoted by ϵ, read *is* or *belongs to*) of an individual to a class (containing it),

(3) The notion *such that*, denoted by $\ni$ (inverse of the Greek letter ϵ).

And the primitive propositions are

(1) $k\epsilon\}x\ni\phi(x)\}\supset\phi(k)$,

(2) $\phi(x)=\Psi(x).\supset:x\ni\phi(x).=.x\ni\Psi(x)$.

The Logic of Relations.—In this calculus, which Russell has shown to be the logic *par excellence* of mathematics, the primitive notions are

(1) Relation, denoted as a class by rel and as individuals by such capitals as R, R', etc.,

(2) Identity, denoted by the symbol 1'.

The primitive propositions are

(1) $R\epsilon\mathrm{rel}.\supset:xRy.=.x$ has the relation R to y,

(2) $R\ni\mathrm{rel}\supset\exists\,\mathrm{rel}\frown R'\ni(xR'y.=.yRx)$,

(3) $\exists\,\mathrm{rel}\frown R\ni(\rho=\iota x.\rho=\iota y)$,

(4) $\smile{}'K\epsilon\mathrm{rel}$,

(5) $\frown{}'K\epsilon\mathrm{rel}$,

(6) $R_1R_2\epsilon\mathrm{rel}$,

(7) $-R\epsilon\mathrm{rel}$,

(8) $\epsilon\epsilon\mathrm{rel}$,

(9) $1'\epsilon\mathrm{rel}$,

(10) $x1'x$,

(11) $1'\supset\breve{1}'$,

(12) $R\epsilon\mathrm{rel}.xRy.y1'z\supset.xRz$.

To the foregoing primitives must be added the notion of *denoting*, which has been made the topic of a most subtle and luminous discussion by Russell in the fifth chapter of the work above cited. The notion is that of the sense in which an individual is denoted by a concept that occurs in a proposition that is not a proposition about the concept, as "She bought *a beautiful gown*"—the thing purchased be nothing so tenuous and translucent as the concept, a beautiful gown, but presumably a concrete thing reasonably opaque.

By way of elucidating the foregoing and further sketching out the three divisions of logic, I shall now proceed to give some explanation of the primitive terms and a statement of the principal definitions and theorems composing them.

Definitions and Theorems in Propositional Logic.—The central term, proposition, is defined in terms of (material) implication, namely, a proposition is that which implies itself. The two varieties of implication are often confused and the distinction between them, being difficult to draw sharply and clearly, is to be acquired very much as a child learns to distinguish

cats from dogs. For one thing material implication subsists only between propositions while formal implication, though it is present in propositional logic, holds only between propositional functions. Now a proposition to be such must be true or else false, while a propositional function, say, x is a number, though it has the form of a proposition is not one, being neither true nor false, until the unspecified term or terms (x in the example cited) are specified and then we have no longer a function but a proposition. The implication postulated in the primitive propositions is material. The meaning of (1) is that if $p\supset q$, then $p\supset q$ is a proposition; (2) means that whatever implies anything is a proposition; and that of (3) is, whatever is implied is a proposition. Number (4), which does not admit of completely symbolic statement, is the postulate that justifies the advance from the hypothetic to the categoric—the advancement involved in passing from saying "such and such a conclusion is true *if* the premises are true" to saying, once the premises are granted true, "the proposition" (not now regarded as a conclusion) "*is* true."

One of the most striking facts in the propositional logic is the theorem that every false proposition implies all propositions and that all true propositions are implied by every proposition. The shocking character of the theorem—which refers, of course, to material implication only—disappears on reflecting that the proposition, p implies q, means simply "q or not-p"—means, that is, "q is true or p is false" and *nothing else;* for surely it is nothing shocking to affirm that a proposition that is not contradicted by any proposition in the class of true propositions is a member of the class; and that affirmation seems equivalent to asserting that "p implies q" is true unless q is false and p true. If you assert of two propositions p and q that p implies q, thereby meaning simply and solely that q can not be false and p true, then unless it happens that at once q is false and p true, there would seem to be in the arsenal of refutation no weapon with which your assertion may be struck down. The primitive propositions are some of them far from being "self-evident." It is not essential that they should be. They are chosen with reference to their sufficiency and look for justification to the body of their consequences. In these they shine—not *a priori* but *a posteriori*. Neither can they be proved true by deducing them from a theorem that is itself deduced from them—to say which is, of course, but to utter a commonplace. As an exercise, however, it is legitimate as well as interesting and instructive to assume the foregoing theorem as a postulate and as such to apply it as a test to the primitive propositions in question. Thus, to take a single example, the procedure in the case of (8) would be as follows. Let r be true and p and q either or both be false or true; then $q\supset r$ is true, hence $p\supset .q\supset r$ is true, hence (8) is true. Let r be false and p and q be true; then $p\supset p$ and $q\supset r$ are both true, pq is true, $pq\supset r$ is false, hence what precedes the colon is false, hence (8) is true. And so on for the remaining possible suppositions respecting p, q and r.

Two propositions are *equivalent* if each implies the other, and we write $p=q$. Two propositions are equivalent when and only when both are true or both are false. The fundamental operations of propositional *multiplication* and *summation* are definable as follows: We may first define the *logical product* of the two *special* propositions—a is a proposition, b is a proposition—to be the proposition, a is a proposition and b is a proposition. Then, denoting this special product by $a\supset a.b\supset b$,

the logical product, pq or $p\frown q$, of *any* two propositions, p and q, may be formally defined by the definition:

$$p\supset p.q\supset q.r\supset r.\supset:.pq=:p\supset(q\supset r).\supset r.$$

This definition of the notion—vulgarly called the joint assertion of p and q—may be rendered thus: p, q, r being propositions, the product of p and q is the proposition—any proposition r such that p implies that q implies it, is true. The *logical sum*, $p\smile q$, of two propositions p and q admits of the definition:

$$p\supset p.q\supset q.r\supset r.\supset:p\smile q=:p\supset r.q\supset r.\supset r;$$

that is, p, q and r being propositions, $q\smile p$ is the proposition equivalent to the proposition that r is implied by the product of $p\supset r$ and $q\supset r$. Such is the definition of the phrase, p or q. It is noteworthy that, whilst pq is true when and only when p and q are *both* true, the sum $p\smile q$ is true whenever *either* p or q is true. Among cardinal theorems I will, further, mention the laws of tautology, commutation, association and distribution:

$$pp(\text{or } p^2)=p, \quad p\smile p=p;$$
$$p\frown q=q\frown p, \quad p\smile q=q\smile p;$$
$$(p\frown q)\frown r=p\frown(q\frown r), \quad (p\smile q)\smile r=p\smile(q\smile r);$$
$$p\frown(q\smile r)=(p\frown q)\smile(p\frown r),$$
$$p\smile(q\frown r)=(p\smile q)\frown(p\smile r)=p\smile q\frown p\smile r.$$

The *negative*, $-p$, of p is a proposition definable thus:

$$p\supset p.q\supset q.\supset:-p=.p\supset q,$$

which states that $-p$ is the proposition equivalent to the proposition that p implies all propositions; and we have the theorem of *double negatives:* $-(-p)=p$. Also the theorems of contradiction and excluded middle: $-p\frown q$ is false; $-p\smile q$ is true.

Definitions and Theorems in Class Logic.—As already pointed out, a propositional function—say, x is a pragmatist, or tan $x=y$—though a proposition in form, is not one in fact, being neither true nor false. But such a function yields a proposition whenever the indeterminate terms, as x, y, are replaced by determinate terms. Thus any such function is a sort of envelope of a limitless number of propositions. A function being given, those terms that on being substituted for its indeterminates yield true propositions are said to constitute a *class*. The symbolism $x\ni\phi(x)$ means "the class of terms x such that $\phi(x)$ is true," and primitive proposition (1) asserts that, if the individual k is a member of the class, $\phi(k)$ is true. Two functions $\phi(x)$ and $\Psi(x)$ are said to be *equivalent* when the propositions of every pair of propositions obtainable by substituting definite terms for x are equivalent; and (2) states that when two functions are equivalent the corresponding classes are the same—composed of the same individuals. If the propositions derivable from $\phi(x)$ are all of them false, the function is said to determine a *null-class;* and it readily follows that all null-classes are *extensionally* the same, so that we can, in this sense, speak of *the* null-class. The definition and symbolic expression of "x is identical with y," x and y being individuals, is $x=y.=:x\epsilon u.\supset_u.y\epsilon u$, where $\supset_u$ means "implies for every (class) u." The relation in question is *symmetric*, a fact involved in the theorem, $x=y.=.y=x$. A *singular* class u (class of but one term) is defined to be such that

$$x\epsilon u.y\epsilon u.\supset.x=y;$$

and a singular class u is symbolically distinguished from its term a by writing ιa to denote u, and $\text{℩}u$ to denote a; so we have $\iota a=u$, $\text{℩}u=a$, and $\text{℩}\iota u=u$, but not $u=a$. The notion of *inclusion* of the terms of a class u by a class v is denoted by $u\supset v$ (where $\supset$ is the symbol for "implies" in propositional logic) and is defined to be

such that $u \supset v . = : x \epsilon u . \supset . x \epsilon v$. Two classes u and v are (extensionally) *identical*, and we write $u = v$, when and only when $u \supset v$ and $v \supset u$. Two classes are *disjoint* if neither includes a term of the other. It is necessary to avoid confounding ϵ with the use of $\supset$ in class logic, the former holds between an *individual* and a class but $\supset$ holds only between classes. Thus, if class $u \supset$ class v, and if individual $a \epsilon u$, we can not write $a \supset v$.

The important notions of class *multiplication* and *summation* are definable as follows. The logical *product* of the classes u and v, which is denoted by $u \frown v$, is such that $u \frown v = . x \ni (x \epsilon u . x \epsilon v)$; while the logical *sum*, $u \smile v$, u and v being disjoint or not, is such that $u \smile v . = . x \ni (x \epsilon u . \smile . x \epsilon v)$. Among cardinal theorems are the laws of *tautology, commutation, association, distribution* and *double negation:*

$$u \frown u = u = u \smile u;$$

$$u \frown v = v \frown u, \quad u \smile v = v \smile u;$$

$$u \frown (v \frown w) = (u \frown v) \frown w. \quad u \smile (v \smile w) = (u \smile v) \smile w;$$

$$u \frown (v \smile w) = (u \frown v) \smile (u \frown w),$$

$$u \smile (v \smile w) = (u \smile v) \smile (u \smile w);$$

and $-(-u) = u$, where $-u$, called the negative of u, is, by definition, such that $-u . = . x \ni (x - \epsilon u)$.

The foregoing sketch indicates how the class logic sends its roots down into the soil of the propositional logic, and there is at the same time exhibited a remarkable parallelism between the two logics. It is important, however, to note the fact, pointed out by Schröder, that the parallelism is not thoroughgoing. For example, if p, q, r be propositions and a, b, c be classes, we have

$$pq \supset r . = : p \supset r . \smile . q \supset r,$$

but *not*

$$a \frown b \supset c . = : a \supset c . \smile . b \supset c.$$

Explanations, Definitions and Theorems in Relational Logic.—In its present form this calculus is mainly the creation of Mr. Bertrand Russell. It was he who perceived and demonstrated the advantage of adopting the extensional as distinguished from the intensional view of relations. It was he who perceived and demonstrated its preeminent importance in and for mathematics. Finally, it was he who cast its general principles—primitive propositions, fundamental definitions, theorems and their proofs—in symbolic form (cf. *Revue de Mathematiques*, vol. 7, 1900–1901).

In order to understand the doctrine including its primitive propositions above given, it will be necessary to explain or define the principal concepts involved in it and to associate with them the symbols (including those already explained) by which they are denoted. These concepts and symbols are as follows, the numbers (1), (2), $\cdots$ referring to primitive propositions. The writing xRy means to assert that x has the relation R to y, so that a relation has *sense* or direction; the symbols ρ and $\breve{\rho}$, called respectively the *domain* and the *codomain* of R, denote respectively the classes of terms that may stand before R and after R; the logical sum of these classes is the *field* of R; if x be a term of ρ, $\breve{\rho}x$ denotes the class of terms y such that xRy, and if x be a term of $\breve{\rho}$, ρx is the class of terms y such that yRx; a class is said to *exist* unless it be a null-class, and the *existence* of a class is affirmed by writing $\exists$ before its symbol, as in (3); if u is a class of terms of ρ, $\breve{\rho}u$ is the class of terms y such that, given any one of them, there is in u an x for which xRy; on the other hand, u again being a class of terms of ρ, $u\breve{\rho}$ denotes the class of terms y such that for *every* term x of u we have xRy; if, now, u is a class of terms in the codomain $\breve{\rho}$, ρu denotes the class of terms such that, given any one y of them, there is in u a term x for which yRx, while, on

the other hand, $u\rho$ is the class of terms such that, given any one y of them, we have, for *every* x of u, yRx; R is said to be *included in* R', $R \supset R'$, if and only if, for all x's and y's, xRy implies $xR'y$; and R and R' are *equivalent* when and only when each of them includes the other; (2) asserts that, given any R, there is a relation R'—called the converse of R and denoted by $\breve{R}$—such that xRy and $yR'x$ are equivalent functions; a relation R is said to be *symmetric* when and only when $R = \breve{R}$; (3) affirms that, given any two terms x and y, there is between them a relation that does not subsist between the terms of any other pair of terms; the logical *sum*, $R_1 \smile R_2$, of two relations R_1 and R_2 is a relation such that the proposition $x(R_1 \smile R_2)$ is equivalent for all x's and y's to the logical sum of the propositions xR_1y, xR_2y; the logical product, $R_1 \frown R_2$, is such that $x(R_1 \frown R_2)y$ is equivalent to the product $xR_1y.xR_2y$, for all x's and y's; if K be a class of relations, their *sum*, $\smile$'K, affirmed by (4) to be a relation, is a class of relations such that, given any one R of them and any pair x, y for which xRy, there is in K a relation R' for which $xR'y$, and that, given any R' of K and a pair x, y for which $xR'y$, there is in the sum-class an R for which xRy; similarly the *product*, $\frown$'K assumed by (5) to be a relation, is the class of relations such that, R being any one of them and x and y being a pair for which xRy, then, for *every* R' of K, $xR'y$, and conversely, if x and y be a pair for which $xR'y$ holds for every R' of K, there is in the product-class an R for which xRy; R_1 and R_2 being relations, their *relative product*, R_1R_2, affirmed by (6) to be a relation, is defined to be such that, if xR_1R_2z, there is a y for which xR_1y and yR_2z, and that, if xR_1y and yR_2z, then xR_1R_2z; R^2 means RR; a relation R is transitive if and only if R^2 is included in R, that is, if the product of xRy and yRz implies xRz; R being a relation, its *negative*, $-R$, affirmed by (7) to be a relation, is defined to be such that, $x - Ry$ is true or false according as xRy is false or true; if y is a class of classes, their *sum* 'y is the class of terms x such that $x\epsilon^2y$; *diversity*, 0', is defined to be the negative of identity, so that $0' = -1'$; R is a *uniform* relation, $Nc \rightarrow 1$, when and only when, whatever x of ρ be given, there is one and but one y for which xRy; R is a *couniform* relation, $1 \rightarrow Nc$, when $\breve{R}$ is uniform; R is a *biuniform* relation, $1 \rightarrow 1$, when it is both uniform and couniform.

Such are the chief of the concepts in the superstructure of the logic of relations. In the study of relations one is close to reality. We do not say with Hegel "Das Seyn ist das Nichts" but rather with Lotze "Being consists in relations." The realm of the thinkable is filled by a multidimensional tissue of relations. These are finer than gossamer but stronger than cables of steel. Among the *theorems* of the general theory the following, which are readily proved by means of the symbolic machinery, are cardinal. Each relation R has one and but one converse relation $\breve{R}$; the converse of the converse of a relation is equivvalent to the relation, that is, $\breve{\breve{R}} = R$; if $R_1 = \breve{R}_2$, then $\breve{\rho}_1 = \rho_2$, and $\rho_1 = \breve{\rho}_2$, and, if the latter two equivalences subsist, then $R_1 = R_2$; also, if $R_1 = \breve{R}_2$, then $\breve{R}_1 = R_2$; the converse of the relative product of two relations is equivalent to the relative product of their converses reversed in order, that is $(\breve{R_1R_2}) = \breve{R}_2\breve{R}_1$; if R is transitive and if xRz, there exists a y such that xRy and yRz; the converse of the negative of a relation is equivalent to the negative of the converse of the relation; a null-class is included in every other class; if, for every x in the domain ρ of

R, xRy is equivalent to $y\epsilon x$, then $R = \breve{\epsilon}$; if u and v are existent (not null) classes, there exists a relation subsisting between every term of u and every term of v but not between other two terms; if u is an existent class, there exists a relation R such that xRu implies for every x both $\rho = u$ and $x\epsilon u$, and, conversely, the product of $\rho = u$ and $x\epsilon u$ implies xRu for every x; identity is transitive; identity is equivalent to its converse; the relative product of identity by itself is equivalent to identity; diversity is equivalent to the converse of diversity; if $R_1\breve{R}_2$ is included in diversity, so is $\breve{R}_1R_2$, and conversely; identity is biuniform; if a relation is biuniform, so is its converse; if a relation is couniform, the relative product of it and its converse is included in but is not always identical with identity; if two relations are biuniform, so is their relative product; given that R_1 and R_2 are uniform relations, that u is a class included in ρ_1, that $\breve{\rho}u$ is included in ρ_2 and that $R_1R_2 = R$, then the two classes, $\breve{\rho}_2(\rho_1u)$ and $\breve{\rho}u$, are equivalent; if R_1 is uniform and if $R_2 = R_1\breve{R}_1$, then R_2 is transitive and symmetric; conversely, *if an existent relation R_2 is transitive and symmetric, then there exists a uniform relation R_1 such that $R_2 = R_1\breve{R}_1$.*

So striking as well as important is the theorem last stated that I can not refrain from presenting its demonstration, which runs as follows: R_2 being given, ρ_2 is also given: let x be a term of ρ_2, and denote by u the class $\breve{\rho}_2x$; let R_1 be such that xR_1u means $x\epsilon\rho_2$ and $u = \breve{\rho}_2x$; then, if yR_1u, $y\epsilon\rho_2$ and $u = \breve{\rho}_2y = \breve{\rho}_2x$; but, if xR_1u and yR_1u, then, $xR_1\breve{R}_2y$; and, as R_2 is transitive and symmetric, xR_2y; hence, as $xR_1\breve{R}_1y$ implies xR_2y, $R_1\breve{R}_1$ is included in R_2; again, as R_2 is transitive and symmetric, if xR_2y then $x\epsilon\breve{\rho}x$, and so xR_2y implies $xR_1\breve{\rho}x$ and $yR_1\breve{\rho}x$, and hence implies $xR_1\breve{R}_1y$; hence R_2 is included in $R_1\breve{R}_1$; hence $R_2 = R_1\breve{R}_1$; moreover, R_1 is uniform, its codomain consisting of the single term u. Hence the theorem.

As in the case of propositions and in that of classes, so here, too, are valid the theorems of tautology, association, commutation, distribution and double negation:

$$R \frown R = R = R \smile R;$$

$$(R_1 \frown R_2) \frown R_3 = R_1 \frown (R_2 \frown R_3),$$

$$(R_1 \smile R_2) \smile R_3 = R_1 \smile (R_2 \smile R_3);$$

$$R_1 \frown R_2 = R_2 \frown R_1, \quad R_1 \smile R_2 = R_2 \smile R_1;$$

$$R_1 \frown (R_2 \smile R_3) = (R_1 \frown R_2) \smile (R_1 \frown R_3),$$

$$R_1 \smile (R_2 \frown R_3) = (R_1 \smile R_2) \frown (R_1 \smile R_3);$$

$$-(-R) = R.$$

Awhile ago I promised to "explicate" the thesis of modern logistic, to state it, that is, explicitly in terms of the logical primitives upon which as the sufficient foundation it asserts that the entire body of mathematics, both actual and potential, stands as a superstructure. The primitives in question have been given; so that, except for a restatement of the thesis in terms of them—which I shall omit as being now easy and involving useless repetition—I may claim to have done much more than fulfil the promise; for I have given in addition to the primitives, which were all that was essential, a digest of modern logic. Indeed, the concepts above defined and the theorems above stated, though they are conventionally assigned to logic, are evidently, if the thesis be true, genuine parts of mathematics.

How is the thesis, if true, to be established? Obviously not, in the ordinary sense, as the conclusion of a syllogism. No, it affirms that a certain thing can be done, namely, that all definable mathematical ideas and all mathematical theorems are respectively definable and demonstrable in terms of the primitives given. The only way to show that the deed is

performable is to perfrom it. Here nothing can succeed except success. Happily the procedure in question need not be applied to *all* mathematical concepts and theorems but only to those—and they are not so numerous—upon which, it is admitted, the remainder rest. Well, an examination of the volumes of the *Revista di Matematica* and of its continuation, the *Revue de Mathematiques,* will show that the principal mathematical branches have been successfully subjected to the treatment in question, with reference, however, to primitive-systems differing somewhat from that above given. As for the latter system, its adequacy to the demands of the thesis has been shown by Russell in his "Principles" with approximate completeness and with as much rigor as discourse, mainly non-symbolic, can be reasonably expected to attain. If, as is to be expected, new branches of mathematics shall arise in the days to come, though we can not be absolutely certain, we may confidently expect that they will be congruous with existing doctrines and will not demand a radical change in foundations.

Process of Testing the Thesis Illustrated.—The little time that remains to me for this address, I shall devote to illustrating by means of a few cardinal examples, the procedure by which the thesis is justified. And I shall begin with the concept of *cardinal number.* Before defining *cardinal number of a class,* we define what is meant by *sameness* of cardinal number, or, better, what is meant by saying this class and that have the same cardinal number. Two classes a and b are said to have the same cardinal number when there is a biuniform relation, or, as we commonly phrase it, a one-one correlation between them. A slight change in the statement is necessary to prove suitable for zero. Then the cardinal number of a class a is defined to be *the class* whose terms are the classes having each of them, according to the preceding definition, the same cardinal number as a. Thus with each class is associated a definite cardinal number. That of the null-class is named *zero* and denoted by 0; that of a singular class is called *one* and denoted by 1. Addition of cardinals is definable in terms of logical addition of classes: if a and b be two disjoint classes having respectively the numbers α and β, the sum $\alpha + \beta$ is the number of the logical sum (a class) $a + b$ of a and b. If a and b are singular classes, the cardinal of their sum may be named *two* and denoted by the symbol *2*, in which case $1 + 1 = 2$; and so on. *Multiplication* of cardinals is also defined in purely logical terms. This is done by means of the concept (due to Whitehead) of *multiplicative* class, which is itself given in terms of logical constants: k being a class of disjoint classes, the *multiplicative class* of k is the class of all the classes each of which contains one and but one term of each class in k. Then the *product* of the cardinal numbers of the classes in k is defined to be the cardinal number of the multiplicative class of k. As multiplication and addition in class logic are commutative, associative and distributive, it readily follows that these laws are valid for cardinal numbers. In the manner indicated the entire theory of cardinals can be established. And thus it appears—to refer again to an example before cited—that the foundation assumed by Weierstrass for the theory of the real variable is itself underlaid by a basis in pure logic.

It is noteworthy that the foregoing concept of cardinal is independent of the (as yet undefined) notion called *order* and that it equally comprises both *finite* and *infinite* cardinals, the distinction of finite and infinite being this: the cardinal number of a class a is infinite or finite according as a is or is not such that there is a class b com-

posed of some but not all of the terms of a and having to a a biuniform relation. In respect to the finite cardinals, they may be defined as follows, presenting them in what, once order is defined, will be called a *series*, 0, 1, 2, . . . Let zero (0) be defined as above; let the *cardinal next after the cardinal* n be defined to be the cardinal $n+1$; let N, the class of finite cardinals, be defined to be the class of cardinals that are contained in every class that contains 0 and contains $n+1$ if it contains n. It remains then to show that the two definitions of finite cardinals are equivalent, and that can be done.

Cardinals, we have seen, are *classes*. The ordinary rational numbers, or fractions, are not classes, but are, as we shall see, *relations* of finite cardinals. Let a be any given finite cardinal, and let x and y be any finite cardinals such that $xa=y$. Denote by A the relation such that xAy is equivalent to $xa=y$. Similarly, to any finite cardinal n there corresponds a relation N whose domain and codomain are respectively composed of all the finite cardinals x and y such that $xn=y$. If $ab=p$ and $cd=p$, that is, if $ab=cd$, then aBp and cDp, whence $p\breve{D}c$, so that $aB\breve{D}c$. The relation $B\breve{D}$, the relative product of B and the converse of D, is named rational number, or fraction, and denoted by b/d. If $ab=cd$, it readily follows that $b/d=a/c$. The rational $n/1$ is commonly denoted by n, but the rational n and the cardinal n are radically different, the former being a relation while the latter is a class.

The cardinals and rationals are signless. Like the rationals, positive and negative integers and fractions are relations but they are relations of a different type. Suppose the finite cardinals arranged as by their second definition above given. Let R be such that xRy, x and y being finite cardinals, means that, in the mentioned arrangement, y is the immediate successor of x; then $x\breve{R}y$ means that y is the immediate predecessor of x. It is readily proved that R^p is the converse of $(\breve{R})^p$ or, what is the same, of $\breve{R}^p$. The relations R^p and $\breve{R}^p$ (p being a finite cardinal) are defined to be the positive and negative integers familiarly denoted by $+p$ and $-p$ respectively. Thus to each finite cardinal p there corresponds a positive integer, $+p$, and a negative integer, $-p$. If x, y and p are finite cardinals, the propositions, xR^py and $x+p=y$, are equivalent; so, too, are $x\breve{R}^py$ and $y+p=x$ or $x-p=y$. Similarly if x be a rational number, and if y and z stand for any two rational numbers so related that $y+x=z$, the relation in question is denoted by $+x$; but if y and z are so related that $y-x=z$, the relation is denoted by $-x$.

Before speaking of the *ordinal number*, it is necessary to tell what is meant by saying of a class that it is ordered or that its terms are arranged in a *series*. This, which is one of Russell's most brilliant achievements, was accomplished as follows. I here but indicate the method and state the result. The method was precisely that of research in natural science, namely, he collected together the various kinds of relation by which what is called order, whatever order in its essence should turn out to be, is generated. These relations, which he found to belong to one or another of six distinct types, turned out, upon penetrating analysis, to be reducible to a single type, namely, that of relations at once *transitive* and *asymmetric*, an asymmetric relation R being such that, if xRy, then not yRx. The conclusion may be stated to be that, a class being given, if there exist a transitive asymmetric relation R such that, x and y being any two whatever of its terms, either xRy or else yRx, the class is

thus arranged in a *series;* and that order otherwise generable is generable by such a relation. The result is of course subject to such doubt as must always attend the method employed, but its correctness seems highly probable. It can be easily proved that, given any three terms x, y, z of an open series, we have xRy and yRz, or yRz and zRx or zRx and xRy, that is, one of the three terms is *between* the other two; and if the series be closed, like that of the points of a circle, it can be rendered open by *cutting* it—that is, by regarding it as beginning (or ending) with some (any) definite term.

We are now prepared to present the notion of ordinal number. If, given two series s_1 and s_2, there subsist between them, regarded as classes, a biuniform relation R such that, a_1 and b_1 being any two terms of s_1 and a_2 and b_2 their respective correspondents (through R) in S_2, a_1 precedes or follows b_1 according as a_2 precedes or follows b_2, then the series s_1 and s_2 are said to be *like*. Plainly likeness is a transitive and symmetric relation. Two like series are said to have the *same ordinal number* or the *same order-type*. Herewith ordinal number, or order-type, of a series is yet not defined. The definition is: the ordinal number, or order-type, of a series s is the *class* of all series like it. Or, defining *like* relations to be such as generate like series, we can define ordinal number, or order-type, of a series-generating relation to be the class (a relation by primitive proposition) of series like it. The definition does not distinguish finite and infinite and so applies to both. In case the terms of a series constitute a finite class, the cardinal number of the class and the ordinal number of the series obey the same laws and are commonly denoted by the same name and symbol. Yet they are radically different notions. For example, the *cardinal three* includes the class composed of a, b and c, but not the series a, b and c as such, while the *ordinal three* includes the series but not the class. On transition to infinites the distinction is forced upon us, for infinite cardinals obey, for example, the law of commutation, while the infinite ordinals do not.

I have time for but a single indication pointing the way to the concept and theory of *real* numbers. Consider, for example, the two familiar classes: A, the class of rationals less than 2; B, the class of rationals whose squares are less than 2. Each of these classes possesses the properties: (1) it does not contain all the rational numbers; (2) it contains all the rational numbers less than any one of its numbers; (3) every number in it is less than some other number in it. Any class of rationals that has the three properties is named *segment* (of rationals). Given a segment s, the class of rationals not belonging to s may be called the *cosegment* of s. It is found that the class of all segments admits of a theory precisely isomorphic with that of the real numbers as usually defined. Hence the segments are named *real numbers*. Segments fall into two classes according as their cosegments have or have not a smallest rational. In the former case the segment is called a *rational* real number. Thus segment A is the rational real *two* or 2. In the other case, the segment is called an *irrational* real number. Thus segment B is the irrational real commonly denoted by $\sqrt{2}$. It is obvious that segments and reals might just as well be defined by the relation greater than instead of less than. The decisive advantage of the foregoing definition, which makes no appeal to the (as yet) undefined notion of *limit*, is that it avoids the necessity of *assuming* a limit where there is none, as in case of class B.

It is to be noted that in usage various kinds of numbers are denoted by the same symbol. This is due to the fact that custom antedates criticism. Thus 2 stands for a cardinal (a class), for a positive integer (a relation), for a rational number or fraction (a relation), for an ordinal (a relation), and for a rational real (a class)—neither the classes nor the relations being of the same kind.

Passing now to the notion of the (linear) *continuum,* it is to be defined in ordinal terms and without the logically vicious assumption often tacitly made that the continuum to be defined is already immersed in a continuum. The following procedure is due to G. Cantor. Let η denote the order-type of series *like* that of the rationals taken in so-called natural order. Any series of this type has the following properties, all of them ordinal: (1) it is denumerable; (2) it has neither beginning nor end; (3) it is compact. A series of terms in a series of type η is said to be *fundamental* if it is a *progression,* that is, if it is like the series 1, 2, 3, $\cdots$; and it is described as *ascending* or *descending* according as its terms follow one another in the same sense (or direction) as do those of the series η or in the reverse sense. A term of a series is a *limit* if it immediately follows (or precedes) a class of terms of the series and does not immediately follow (or precede) any one assignable term of it. It follows that a fundamental series s of a series η has a limit if in η there is a term that is first after or first before all the terms of s according as s is ascending or descending. A series is said to be *perfect* if (1) all its fundamental series have limits and (2) all its terms are limits of fundamental series. It can be proved that a series whose terms are terms of a perfect series and which, besides being denumerable, are so distributed that there is one between every two terms of the perfect series, is a series of type η. We can now define: a series θ is *continuous* if it is perfect and contains a denumerable class of terms such that there is one of them between every two terms of θ. The definition is based upon the properties found to characterize the series of real numbers from 0 inclusive to 1 inclusive.

The significance of what has been said is by no means confined to analysis. Yet I wish, in closing, to refer explicitly to geometry. As a branch of mathematics, geometry does not claim to be an accurate or true description of actual or perceptual space, whatever that may be. As for the notion and the name of space, it does not seem to be a *modern* discovery that they are not essential to geometry, for, as Peano has pointed out, neither the one nor the other is to be found in the works either of Euclid or of Archimedes. What, then, is geometry? And how related to the thesis of modern logistic? The answer must be in terms of *form* and *subject-matter.* As to form, geometry is, as Pieri has said and by his great memoirs has done as much as any one to show, a purely "hypothetico-deductive" science. It is true indeed that in each of the postulate-systems—whether those of Pieri or of Pasch or of Peano or of Hilbert or of Veblen or of others—that have recently been offered as basis for descriptive or projective or metric geometry or for any sub-division of those grand divisions, there occurs at least one postulate in categoric form, as, for example, "there exists at least one point"—thus seeming to assert or to imply that the geometry in question, whatever variety it may be, transcends the hypothetic character and has in fact validity of an extra-theoretic or external kind. Nevertheless, the seeming is appearance only. What the geometrician really asserts, and he asserts nothing

else, is that, *if* there be terms, which he calls points, and might as well call "roints" or "raths" or "momes" or any other name (what's in a name?), that satisfy the given postulates, then they satisfy certain propositions called theorems. The only existence asserted by or in geometry is thus the existence of certain *implications*. As to subject-matter, that of geometry, as Russell has, I think, shown beyond a reasonable doubt, is multiple series or, more radically, the relations by which such series are generated or in which they extensionally consist.

I wish to add in closing that this address had not been possible but for the far-reaching researches and brilliant expositions of Schröder, Russell and Couturat in the works already cited.

C. J. Keyser
Columbia University

CHEMISTRY AT HARVARD UNIVERSITY

The following letter has been prepared by the committee of overseers to visit the chemical laboratory of Harvard University and by several others who are especially interested in the subject:

Harvard University is in urgent need of the endowment of modern facilities for chemical instruction and research.

Some progress toward such an endowment has already been made by the conditional offer of contributions for the construction of a special laboratory for research in physical and inorganic chemistry, as a memorial to Wolcott Gibbs.

Wolcott Gibbs was a pioneer in scientific research in the field of inorganic and physical chemistry, and for many years was considered the foremost chemist of America. He died on December 9, 1908, in his eighty-seventh year. The greater part of his useful life was spent as Rumford professor at Harvard University, and it is eminently fitting that any memorial to this great and good man should take a form which would further that branch of chemistry to which he had devoted his splendid abilities.

This project forms a highly suitable beginning of the much-needed endowment of modern facilities for chemical instruction and research at Harvard University, because in precise investigations of this kind Harvard is among the leading institutions of the world. Such work demands, for its highest development, construction and facilities superior to any now in existence; and above all this laboratory should be designed for research only, and separated from the rooms in which elementary teaching is conducted. The new building would also partially relieve the very disadvantageous and unhygienic condition of Boylston Hall, now one of the most crying evils in Harvard University.

This Wolcott Gibbs Memorial Laboratory would form part of the group of several buildings necessary for the adequate accommodation of the department of chemistry. The report of the Committee of Overseers to Visit the Chemical Laboratory contains a provisional plan of this projected group, which offers a magnificent opportunity for other large gifts. These would form dignified memorials of benefactors or those named by them, as well as permanent sources of usefulness to Harvard and to America.

The report just mentioned calls attention to the important rôle played by pure chemistry in almost all departments of industrial science which contribute towards the health and prosperity of mankind, and concludes:

"The last century has been a century of power, by the perfection of machinery and the development of electricity. The coming century promises to be a chemical century. Should Harvard, if all this be true, be content until it has obtained the best chemical laboratory in the world?"

Towards the erection of the Wolcott Gibbs Memorial Laboratory subscriptions of nearly $53,000 have already been made, most of them upon the condition that $47,000 more be immediately secured. Checks either for this fund or as contributions toward one of the other laboratory buildings may be drawn to the order of Charles Francis Adams, 2d, treasurer of Harvard College, 50 State Street, Boston.

J. Collins Warren,	Charles W. Eliot,
James M. Crafts,	Alexander Agassiz,
Elihu Thomson,	Henry P. Walcott,
E. D. Pearce,	Henry L. Higginson,
Clifford Richardson,	Alexander Cochrane,
Charles H. W. Foster,	Frederick P. Fish,
Morris Loeb,	Harrison S. Morris,
A. Lawrence Lowell,	E. Mallinckrodt, Jr.,

Committee of the Overseers to Visit the Chemical Laboratory

President Lowell's interest is emphatically expressed in the following letter, which he kindly permits to be published:

November 24, 1909.

Dear Mr. Sanger:—

I hope most earnestly that you will be successful in your efforts to raise money for a new chemical laboratory. That Boylston Hall has been inadequate for purposes both of research and instruction has long been lamentably evident, and that Harvard University should not be properly equipped in this field is the more to be regretted, in view of the rapidly increasing importance of chemistry in industry and medicine. It is well known that the industries of America are behind those of Germany in the use of chemical processes, and better chemical facilities at our universities would help greatly towards curing this defect. It seems unfortunate that the magnificent research in chemistry being conducted at Harvard should be hampered by the lack of laboratory room. Yours very truly,

A. Lawrence Lowell

Professor C. R. Sanger.

SCIENTIFIC NOTES AND NEWS

In the present issue of Science are printed the address of the retiring president of the American Association for the Advancement of Science, Dr. T. C. Chamberlin, of the University of Chicago, and of the vice-president of the section for mathematics and astronomy, Professor C. J. Keyser, of Columbia University. In the issue for next week will be printed the proceedings of the Boston meeting, which promises to be of more than usual interest and importance.

The Chicago Geographical Society has awarded the Helen Culver gold medal to Commander Robert E. Peary, for distinguished services in exploration, and to Professor Thomas C. Chamberlin, of the University of Chicago, for distinguished services in geographical research. The medals will be presented at the annual dinner of the society on January 26.

The Paris Academy of Sciences has awarded medals for aeronautic achievements as follows: gold—Wilbur and Orville Wright, Blériot, Farman, Count de Lambert, Santos-Dumont, De La Vauix, Voisin and Count Zeppelin; enamel—Bremuet, Paulhan, Delagrange, Rougier and Esnault Pelterie.

As has been everywhere announced, the University of Copenhagen has reported adversely on the claims of Dr. Frederick A. Cook to have reached the North Pole. This report will not now come as a surprise to any one nor had a different result been anticipated at any time by those conversant with the circumstances, as is indicated by the note published in this journal, on September 10, when the announcement was first made.

Dr. Theo. Gill, of the Smithsonian Institution, and Professor August Brauer, director of the Zoological Museum, Berlin, have been elected foreign members of the Zoological Society of London. The following corresponding members were elected: Mr. E. Salis-Schwabe, of Manaos, Brazil; Professor W. Kukenthal, of Breslau, Germany; Professor Gustave Gilson, of Ostend, Belgium, and Dr. E. G. Racovitza, sub-director of the Laboratoire Arago, Banyuls-sur-Mer, France.

Dr. Ephraim Miller, professor of mathematics and astronomy in the University of Kansas, who will celebrate his seventy-seventh birthday on April 25, will retire from active service at the close of the academic year under the provisions of the Carnegie Foundation.

Professor J. Culver Hartzell, B.S. (Chattanooga), M.S. (Yale), Ph.D. (Munich), has resigned as head of the department of geology and chemistry in the University of the Pacific, the resignation to take effect at the close of the present academic year.

Dr. E. B. Tylor, professor of anthropology at Oxford University, will retire from active service.

Dr. Leo Loeb, assistant professor of pathology at the University of Pennsylvania, will at the close of the present academic year become director of an institution for the study of cancer in St. Louis.

Dr. Shepherd Ivory Franz, psychologist at the Government Hospital for the Insane, Washington, D. C., has been appointed scientific director of that institution.

Mr. W. M. Tattersall has been appointed keeper of the Manchester Museum in succession to Dr. W. E. Hoyle.

Dr. G. Gürich, docent for geology at Breslau, has been appointed director of the Geological Institute at Hamburg, to succeed the late Professor Gottsche.

Professor A. Crum Brown, F.R.S., has been elected president of the Scottish Meteorological Society.

We learn from the London *Times* that Professor Kocher, of Berne, who was recently awarded the Nobel prize for medicine, has announced his intention of dividing the prize into two amounts, one of which he will present to the Red Cross Hospital at Berne. The remaining sum will be used for the benefit of the poorer class of medical students at Berne.

The prize of the Berlin Astronomical Society for the best calculations of the path of Halley's comet has been awarded to Messrs. Cole and Crommelin.

During the past two years Mr. John D. Haseman has been collecting fishes for the Carnegie Museum in South America. His last journey was from Corumba in the valley of the La Plata to Manaos in Brazil. No message having been received from him for seven months, fears for his safety began to be entertained, but they were relieved a few days ago by a message from Manaos, saying "I have come out to civilization, tired and worn out, but still able to catch fish." He has added many thousands of specimens to the collections of the museum.

The board of regents of the University of Minnesota has allowed Professor F. L. Washburn, of the entomological division of the experiment station, two months' vacation, during February and March of the present year. This time will be spent, as far as possible, in the study of conditions governing the control of insects affecting market gardens and small land ownings in Europe.

Dr. Robert Bennett Bean, associate professor of anatomy in the Philippine Medical School, will return to America, reaching Baltimore in February.

Professor Hal Downey, of the department of animal biology of the University of Minnesota, will next year have sabbatical leave of absence to study abroad.

From the members of the American committee appointed by Commissioner Brown for the third International Congress for Home Education to be held in Brussels next summer, the name was omitted of Dr. D. P. McMillin, director of child study and pedagogical investigation in the Chicago public schools. He is chairman of the sub-committee on child study.

Dr. Augusto Righi, professor of physics at Bologna, will next year give a course of lectures at Columbia University.

Mr. Marconi, who received a Nobel prize for physics, lectured in Stockholm on December 11, in accordance with the usual custom, upon radiotelegraphy, before a large body of well-known men of science.

According to *Nature*, on November 24, exactly fifty years after the publication of the "Origin of Species," a number of biological and medical societies of the Netherlands met in one of the large halls of the Amsterdam Zoological Gardens (Natura Artis Magistra) to commemorate this event and the influence which Darwinism has continued to exercise on human thought since then. Addresses were delivered by Professor Hugo de Vries on Darwin's visit to the Galapagos Archipelago, and by Professor A. A. W. Hubrecht on Darwin and the descent of man. A bust of Darwin occupied the center of the hall in front of the platform.

The Pasteur Institute of Paris has presented to the Rockefeller Institute for Medical Research, of New York, a replica of the bronze bust of Louis Pasteur by Paul Dubois, in recognition of assistance rendered during the recent epidemic of cerebrospinal meningitis which prevailed in France.

A monument will be erected in Hilden, Germany, to Guilelmus Fabricius, the eminent surgeon. It is proposed to unveil a statue of Fabricius on the three hundred and fiftieth anniversary of his birth, June 25, 1560.

We are requested by Frau Marie Dohrn to state that in looking through the late Professor Anton Dohrn's papers and manuscripts, much has been found relating to the origin

and growth of the Naples Zoological Station that he founded. Whether from these materials it will be possible to reconstruct a complete history of the station, can not as yet be definitely said; but at all events the many letters that Dohrn wrote to his scientific friends could not fail to fill up many gaps and throw more light on the whole subject. All those, accordingly, who have in their possession any letters from Dohrn, and are willing to give a helping hand in this undertaking, would be doing a great service if they would lend these letters, or copies of them, for the purposes of the work. All communications should be addressed to Frau Marie Dohrn, Rione Amedio, 92, Naples.

Dr. Charles B. Dudley, chief chemist of the Pennsylvania Railroad Company, past president of the American Chemical Society, died at his home in Altoona, Pa., on December 21 at the age of sixty-eight years.

Dr. Ludwig Mond, the distinguished industrial chemist and investigator, a founder of the alkali firm of Brunner, Mond and Co., died in London on December 11, at the age of seventy years.

The U. S. Civil Service Commission will hold an examination on January 12 for the appointment in the Bureau of Standards of an engineer-physicist at $3,000 per year and associate engineer-physicist at $2,000 per year. Applicants should be able to carry on independent research in the field of engineering physics, and should have training and experience in the inspection and testing of engineering and structural materials, the operation of testing machines and the interpretation of the results of investigations. Titles and references to the original source of publication of all papers published should be given.

According to the London *Times*, it is planned to establish in Germany a Chemische Reichsanstalt to undertake for chemical industry similar functions to those which the Imperial Physical Institute performs for engineering. The undertaking is being subsidized by the state, and it is expected that the annual maintenance will cost about £10,000.

A conference on the eradication of the hookworm disease will be held in Atlanta, on January 18 and 19. Delegates will be appointed to the conference from Alabama, Mississippi, South Carolina, Georgia and Florida.

The second general meeting of the International Institute of Agriculture was held at Rome beginning on December 12.

The annual exhibition of physical apparatus organized by the London Physical Society was held on December 14 at the Imperial College of Science, South Kensington.

The annual meeting of the Association of American Universities will be held at the University of Wisconsin on January 4–5. Among the subjects to be discussed at this meeting are "The Problem of the Assistant Professor," to be discussed by a representative of Leland Stanford University; "University Extension," to be presented by Director L. E. Reber, of the extension division of the University of Wisconsin; and "The Position and Importance of the Arts Course as Distinct from the Professional Course," to be read by President Woodrow Wilson, of Princeton.

UNIVERSITY AND EDUCATIONAL NEWS

At a meeting of the senate of the University of London on December 16, a letter was read from Mr. Otto Beit, announcing a large gift in the interest of medical research. Mr. Beit's brother, the late Mr. Alfred Beit, left £50,000 to found an "Institute of Medical Sciences." As the formation of this institute has for various reasons become impossible, Mr. Beit has decided to increase the sum left by his brother to £215,000. This fund, which is to be named "The Beit Memorial Fellowships for Medical Research," is to be devoted to the furthering of medical research work in all its branches. With this object a sum of £250 a year for three years is to be granted "to any man or woman of European descent, graduate of any approved university within the British Empire, who is elected to a Fellowship." The first election of fellows will take place on or before March 1, 1910.

THE Experiment Station *Record* states that the legislature has increased the rate of taxation for the support of the University of California from two to three cents for each one hundred dollars of assessed valuation. This is expected to provide an income for the current year of about $600,000. Appropriations were also made aggregating $130,000 for additional buildings and equipment at the University Farm at Davis, and $88,500 for its maintenance during the ensuing biennium; $20,000 for farmers' institutes; $15,000 for viticultural investigations; $12,000 for cereal investigations, and about $40,000 for the equipment and maintenance of the Southern California Pathological Laboratory.

MRS. PHŒBE HEARST has undertaken to build an anthropological museum for the University of California to cost about $500,000.

TULANE UNIVERSITY will receive $100,000 by will of Isidore Newman, of New Orleans.

THE old block of six tenements at the north end of the Sheffield Scientific School grounds, held for many years at a prohibitory price, has been bought for less than $35,000. It will now be torn down and the chemical laboratory extended over part of the site.

IN order to secure closer cooperation between the regents and the faculties of the University of Minnesota, the board of regents has passed the following resolution:

Resolved, that the several deans of the university be requested to report to the board of regents at their next meeting some plan by which matters concerning the general interests of the university may be taken up and considered by some representative body of those directing the work of the university and the board of regents in closer relation than heretofore.

THE establishment of an agricultural college at Mayaguez, Porto Rico, has been authorized by the territorial legislature. I. W. Hart, of the School of Agriculture, São Paulo, Brazil, has been elected president.

MR. F. A. WOODS, chief of the Bureau of Plant Industry of the U. S. Department of Agriculture, has been elected dean of the agricultural department of the University of Minnesota.

DISCUSSION AND CORRESPONDENCE

"OFFICIAL" LIST OF ZOOLOGICAL NAMES—AN OPEN LETTER TO PROFESSIONAL ZOOLOGISTS

A NUMBER of zoologists have expressed the opinion that a list of the most common zoological names should be prepared and that the International Congress of Zoology should accept this list in the future as free from any operation of the law of priority. Other zoologists view this proposition as theoretically and practically open to very serious objections. In the hope of meeting the wishes of the representatives of both sides of this question I take the liberty of proposing an alternative plan, namely, that a list be made of the most commonly used zoological names, that these names be subjected to rigid study under the present international code, and that the international congress adopt this list as "official," with the provision that no change in any of the names in the list be accepted unless the reason for such change is first submitted to the International Commission on Zoological Nomenclature for careful study and unless said commission decides that the change is justified and necessary.

If the zoologists of the world will cooperate with me in this matter, I will endeavor to report to the International Commission at the Gratz meeting in 1910 a list of the kind proposed. It does not seem advisable to make this official list too large at first, but if the plan is found to be feasible, additional names could be placed on the list year after year, and eventually we would have a catalogue of all of the most common and most important names in zoology.

I invite the zoologists of the world to cooperate with me in this experiment on the following plan: Let any person interested in zoology send to me within the next three months a list of 100 zoological names which he considers the most important, and the most generally used. Let every man who is familiar with nomenclatural usages work out the status, under the international code, of 10 of the 100 names which he submits, giving the

exact spelling, the author, and the date and place of publication, with the statement that he considers the 10 names in question as the correct names of the animals involved.

I will agree to compile all the names sent in, to tabulate the votes on the different names (in respect to their importance and frequency), and if possible to verify the references and the nomenclatural status of the names in question. I will further agree to submit a list of say 100 to 300 such names to the International Commission on Nomenclature and to recommend that the commission report upon the list to the international congress.

All communications on this subject should be addressed to me as follows:

Dr. Ch. Wardell Stiles, secretary, International Commission on Zoological Nomenclature, Hygienic Laboratory, 25th and E Streets, Washington, D. C.

CH. WARDELL STILES

GLACIAL CLAYS OF THE MAINE COAST

FOR a number of years these clays have been greatly neglected by geologists and zoologists. Mr. Frederick G. Clapp, in his recent paper,[1] has summarized and added to the work on this region.

Mr. Clapp gives a list of the Pleistocene fossils found in the clays. To this list should be added the following species of ophiuroids, which I found in August, 1909: two specimens of *Ophiura sarsii* Ltk., and one of *Ophiura nodosa* Ltk. These three specimens were found in close proximity in clay about 110 feet above sea level, by aneroid, and the location was at the Rockland Lime Company's deepest quarry, about two miles west of Crockett Point, in Rockland Harbor. This horizon is in the "Upper Clay" of Mr. Clapp's provisional division of these clays. I am indebted to Dr. Hubert L. Clark, for the determination of the species.

ROBERT W. SAYLES

HARVARD UNIVERSITY

[1] "Complexity of the Glacial Period in Northeastern New England," *Bulletin of the Geological Society of America*, Vol. 18, pp. 505–556, 1908.

SCIENTIFIC BOOKS

The Natural History of Igneous Rocks. By ALFRED HARKER, M.A., F.R.S., Lecturer in Petrology in the University of Cambridge. New York, The Macmillan Company. 1909. Pp. 383, with 112 diagrams and 2 plates.

This volume by Mr. Harker, which presents the substance of a course of lectures delivered at the University of Cambridge, is not a textbook of petrography but treats in a general way of igneous action and igneous rocks in their relation to the structure of the earth's crust, and of the constitution of igneous magmas considered as complex solutions. In the latter portion of the work an exposition is given of numerous and often rather recondite researches into the physico-chemical relations of natural magmas and artificial slags which have been carried out in recent years by Vogt and others.

With respect to the question of the ultimate source of igneous action the author adopts an attitude which is frankly agnostic.

> The nebular hypothesis in Laplace's form, if not discredited, has at least been shown to involve great difficulties to which no answer is yet forthcoming; the meteoric hypothesis, resting from the first on a more precarious basis, is involved practically in the same damaging criticism; and the planetesimal theory has as yet scarcely emerged from the tentative stage.

After considering the relation of igneous action to crustal movements and pointing out that while there has been a rough periodicity in times of activity and repose, there is nothing to support the opinion that there has been a secular waning of igneous action, the geographical distribution of the younger igneous rocks and the question of cycles of igneous activity are discussed. It is shown that the differences in composition of the lavas emitted from neighboring vents, as well as the very unequal heights to which such lavas rise, prove that they can not draw directly from a common source. Each volcanic center must possess its own proper reservoir of lava, but we

must conclude that the local reservoir of an individual volcano is supplied by drafts from some much larger body of rock magma with which it is from time to time in communication. The various types of igneous intrusion are then considered, especial attention being paid to the numerous varieties of laccolitic and bathylitic intrusion. The important question of petrographical provinces and the mutual relations of associated igneous rocks are discussed at length. While recognizing many local and subordinate petrographical provinces, Mr. Harker distinguishes two petrographical regions of the first order of magnitude, an Atlantic and a Pacific region, the two being separated in America by the line of the Andes and Cordillera folding. The former region is characterized by a prevalence of magmas rich in alkalis, while in the magmas of the latter, lime and magnesia are relatively more abundant. The mutual relations of the magmas in a number of well-known igneous areas within these great petrographical regions is then considered and is illustrated by the aid of variation diagrams.

A very interesting and valuable portion of the book is that in which the physical chemistry of rock magmas and the laws which govern their crystallization is considered. In this results of the recent researches of Vogt, Miers, Day, Doelter and others are presented and critically discussed. The structures of igneous rocks are also considered in the light of recent work in the field of physical chemistry. Thus in hypabyssal porphyritic rocks, the phenocrysts often represent the excess over eutectic proportions and the ground mass the quasi eutectic residuum, while in the volcanic rocks the distinction is obscured by the effects of the discontinuous change of physical conditions at the time of extrusion. Micrographic intergrowths, corona, spherulitic and variolitic structures are explained in the light of the laws of crystallization as elucidated by recent studies in physical chemistry.

The function of mineralizers in rock magmas and the formation of certain minerals through their agency is then discussed, leading to the consideration of the active rôle of the volatile constituents, which on the crystallization of the rock enter upon a new phase of activity, partly of a destructive kind to which Bunson applied the term *pneumatolitic*. Then follows the consideration of the metasomatic changes developed in certain rocks when penetrated by igneous intrusions, more especially the phenomenon termed "granitization" by the French geologists.

The very important question of magmatic differentiation in its various phases is then considered, together with the allied question of hybridism in igneous rocks to which Harker has recently made such important contributions as the result of his studies in the western islands of Scotland.

The last chapter deals with the question of the classification of igneous rocks. The "quantitative system" is adversely criticized and the opinion is expressed that a satisfactory classification can not be expected until our knowledge in the domain of petrogenesis is much more extended than it is at present.

The work traverses a portion of the field of geological knowledge which is not covered by our ordinary text-books, although many of the questions discussed are also treated of in the first volume of Professor Iddings's work on "Igneous Rocks," which has just appeared. It is well and clearly written and will repay a careful perusal by all interested in the modern developments of the science of geology.

McGill University Frank D. Adams

Croisière Océanographique accomplie a bord de la Belgica dans la Mer du Grönland, 1905. Duc d'Orléans. Bruxelles, 1907. 4to, 573 pp., 80 plates and charts.

In June, 1905, the Duke of Orleans, having in view a study of the Greenland Sea, sailed from Tromsö, Norway, in the well-known steamer *Belgica*, commanded by A. de Gerlache de Gomery, accompanied by an effective staff. The season being too early for navigation on the Greenland coast the course of the expedition was laid first to the northward by Bear Island, the west and north coasts of Spitzbergen, and then as closely as opportunity permitted skirted the compact southward

extending Arctic pack ice in the hope of finding a passage toward the eastern shore of Greenland through some break in this impassable barrier. Nearly seven degrees of southing were traversed before the *Belgica* could be headed to the westward and, amongst the broken floe ice between the pack ice and the Greenland coast, again struggle to the northward. Under these circumstances a latitude of about 78° 16′ was attained, when the ship retraced her course, leaving the broken ice at a point nearly west of Jan Mayen and thence proceeding to the westward of Iceland, touching at Reykjavik, and so homeward.

Among the special objects of the cruise was the extension and confirmation of Nansen's observations and theories in regard to the conformation of the sea bottom, the currents off the east coast of Greenland, the distribution of marine animal life in the plankton and on the surface of the sea, and the inter-relations of Arctic and North Atlantic waters mingling in the Greenland Sea.

The scientific results are detailed in this truly magnificent volume, in which, of the printer's and cartographer's art, nothing has been spared in the endeavor to approach perfection.

Geographically the more interesting results were the latitude attained by the vessel, a considerable distance further than previous navigators on this dangerous coast; the discovery of a number of new islands off the coast of Greenland; and of a submarine moraine, about forty miles broad off the Greenland coast and parallel with it, which received the name of Belgica Bank.

Space would not suffice to analyze in detail the work accomplished, but a summary of the contents will enable those interested to form a general idea of the results.

A summary, with synoptical charts of the meteorological conditions during the cruise, is given by Dan La Cour. O. B. Böggild contributes a memoir on the submarine sediments and their distribution, with notes on the submarine moraine before referred to and the continental rocks collected. Ostenfeld, C. Jensen, Ferdinandsen, Winge and Deichmann Branth discuss the phanerogams, mosses, fungi and lichens obtained. Helland-Hansen and Koefoed discuss the hydrography in a division of 220 pages luxuriously illustrated by maps and sections, and more than 100 pages are given to a study of the plankton by Koefoed and others. C. Hartlaub contributes a memoir on the medusæ, and Koefoed one on the fishes with fine illustrations of numerous larval forms. J. Grieg describes the invertebrates collected, first on the coast of Spitsbergen and, secondly, from the Greenland Sea, with the assistance of several other naturalists who have determined the species of special groups. Some observations follow on the food of the walrus, bearded seal, *Tringa striata*, and the tom cod. The volume closes with tables of the dredging stations, an enumeration of the scientific staff of the expedition, and a full table of contents; but curiously enough, no index.

This splendid volume, with its wealth of carefully conducted observations, will form a permanent monument to the liberality and good sense of the noble patron of the expedition and a happy contrast to the barren exploits of unscientific pole seekers with which from time to time the daily press concerns itself.

WM. H. DALL

SPECIAL ARTICLES

PRELIMINARY NOTE ON THE CHROMOSOMES IN THE OOGENESIS, FERTILIZATION AND CLEAVAGE OF CERTAIN HEMIPTERA

IN the recent work on the spermatogenesis of the Hemiptera heteroptera it has been shown that in the members of some families of this group, notably the Coreidæ, the spermatogonia have an odd number of chromosomes, one of the latter being the unpaired idiochromosome or "accessory" chromosome. Owing to the fact that this chromosome passes undivided to one pole of the spindle in one of the maturation mitoses while the others divide equally in both, two classes of spermatozoa are formed in equal numbers, one class having the idiochromosome, the other lacking it. The oogonia have been shown to have an even number of chromosomes, there being two equal

in size in place of the unpaired element of the spermatogonia. It has been assumed that in the maturation of the eggs all the chromosomes divide in both divisions, giving to each matured egg a group of chromosomes similar in all respects to that borne by the class of spermatozoa having the idiochromosome. In short, while the dimorphism of the spermatozoa has been shown to be a fact, the similarity of the eggs has rested upon inference only. It has been assumed further that if an egg is fertilized by a spermatozoon bearing the idiochromosome an embryo will be produced whose nuclei all have an even number of chromosomes similar in all respects to the oogonial groups, but if fertilized by a spermatozoon lacking that chromosome, the resulting embryonic nuclei will all have an odd number of chromosomes similar to the spermatogonial groups. The former class of embryos accordingly will be females, the latter males.

It seemed advisable to the writer to examine the oogenesis, fertilization and cleavage of the coreid family and determine if possible whether there is a basis of fact for these assumptions. With this end in view, sections of the eggs of *Archimerus, Anasa, Chelinidea* and *Protenor* were made, some before laying, but chiefly at intervals after laying. Although some difficulties of technique were encountered, fairly good series were obtained. The results are as follows:

The number of oogonial chromosomes in *Archimerus* is 16, in *Anasa* 22, and in *Protenor* 14. In the first polar (oocyte) division, these numbers are reduced to 8, 11 and 7, respectively. The chromosomes exhibit the same number and size relations as in the first spermatocytes except that the idiochromosome is here a bivalent, having resulted in all probability from the synapsis of two oogonial chromosomes. In *Protenor* the idiochromosome-bivalent can be readily identified by its size. In *Archimerus* all the chromosomes divide in both polar (oocyte) divisions and it is probable that the same is true for *Anasa* and *Protenor,* though all stages of maturation were not obtained in these two forms. As a result of maturation all the eggs are of one kind with regard to their chromatin-content, and further the female pronucleus contains a group of chromosomes similar in number and size relations to that of a spermatozoon bearing the idiochromosome. At fertilization the reduced groups in the male and female pronuclei are again distinguishable just before they enter the first cleavage spindle.

In the cleavage and early blastoderm nuclei of *Archimerus, Anasa, Chelinidea* and *Protenor,* the chromosomes can be readily counted, and show the same numbers and size relations as in the gonads, though, as a whole, somewhat more elongated. Two types of embryos are found, one having an odd, and the other an even number of chromosomes, these numbers being respectively the same as occur in the spermatogonia and oogonia. Accordingly, the former are males, the latter females. Thus in *Archimerus* the embryos have either 15 or 16 chromosomes, in *Anasa* and *Chelinidea* 21 or 22, in *Protenor* 13 or 14. In short the sex of an embryo may be determined by counting its chromosomes.

The results in general complete the history of the idiochromosome ("accessory" chromosome) and its mate, showing their behavior in the maturation of the egg and their presence, either singly or together, in the embryonic (somatic) nuclei. They also lend additional support to the theory of chromosome-individuality and to the recent theories of sex-production based upon cytological studies.

C. V. MORRILL

COLLEGE OF MEDICINE,
SYRACUSE UNIVERSITY

SOCIETIES AND ACADEMIES

THE AMERICAN PHYSICAL SOCIETY

THE regular Thanksgiving meeting of the Physical Society was held in the new physical laboratory of the University of Illinois, Urbana, Ill., on Saturday, November 27, 1909. The meeting was well attended, practically all the universities of the middle west, as well as several in the east, being represented. President Henry Crew presided. The following papers were presented:

"Preparation and Properties of the Heusler Alloys," by A. A. Knowlton.

"Hysteresis Tests of Heusler Alloys," by A. A. Knowlton and O. G. Clifford.

"The Magnetic Properties of the Heusler Alloys," by E. B. Stephenson.

"The Effect of Temperature on the Magnetic Properties of Electrolytic Iron," by Earle M. Terry.

"The Point Discharge in Air for Pressures Greater than Atmospheric," by O. A. Gage.

"On the Mechanical Equivalent of Heat by a Porous Plug Method," by J. R. Roebuck. (Read by title.)

"The Elastic Properties of Platinum-iridium Wire," by Karl E. Guthe.

"An Apparatus for Measuring Sound," by F. R. Watson.

"Polarization of Cadmium Cells," by R. R. Ramsey.

"A Method for Determining the Optical Constants of Metals Applicable to Measurements in the Infra-red," by L. R. Ingersoll.

"The Absolute Values of the Moments of Elementary Magnets," by Jakob Kunz.

"An Apparatus for Studying Moment of Inertia," by C. M. Smith. (Read by title.)

"Some Curious Phenomena Observed in Connection with Melde's Experiment," by J. S. Stokes.

"'Porous Plug' and 'Free Expansion' Effects under Varying Pressure," by A. G. Worthing.

"The Absorption of X-rays an Additative Property," by R. A. Millikan and E. J. Moore.

"A Comparison of the Echelon and Diffraction Gratings," by H. B. Lemon.

"The Value of *e* by Wilson's Method," by A. Begeman.

"The Flow of Energy in an Interference Field," by Max Mason.

"The Stark Effect with Canal Rays," by G. S. Fulcher.

Ernest Merritt,
Secretary

THE GEOLOGICAL SOCIETY OF WASHINGTON

At the 222d meeting of the society, held at the George Washington University, on Wednesday evening, November 10, 1909, Mr. Waldemar Lindgren offered an informal communication regarding the discovery of a selenium mineral in the gold-quartz ores of the Republic district, Washington State. The veins, which have yielded several million dollars in gold, are contained in Tertiary andesitic rocks and tuffs. The vein matter is quartz, chalcedony and opal deposited in concentric crusts. "Adularia, in considerable amount, also occurs in the gangue." Ore minerals and particularly native gold are rarely visible in the gangue and the ores have proved very difficult to treat. In rich ores slight, black streaks indicate the presence of metallic minerals and in a few places, in the Republic mine, a well-defined black or dark gray mineral forms crusts a few millimeters in thickness. This material is exceedingly rich in gold, but contains no free metal. It consists mainly of an antimonial tetrahedrite associated with specks of chalcopyrite. A partial analysis by Dr. Palmer, of the U. S. Geological Survey, showed no tellurium, but the presence of about one per cent. of selenium, which in all probability is combined with the gold. This interesting result places the Republic veins in the rare class of Tertiary selenide veins, of which Tonopah is the only known representative in the United States. "From descriptions, one of the few deposits of this kind, outside of the United States, is that of Radjang Lebong in Sumatra." No doubt the difficulties which have been experienced in the treatment of these ores are attributable to the presence of selenium compounds. Further metallographic investigations are now in progress to determine the exact character of the selenide.

Regular Program

Characteristics of some Ore Deposits of Southern Humboldt County, Nevada: F. L. Ransome.

A large proportion of the deposits of southern Humboldt County consist of silver ores carrying varying minor quantities of gold. These ores are prevailingly antimonial, the silver being combined chiefly in tetrahedrite or jamesonite. They generally contain in addition a little galena (probably argentiferous) and sphalerite, with of course some pyrite. The gangue is quartz, and as a rule the sulphides are subordinate to the gangue and are rather finely disseminated through it. Argentite and other rich silver-bearing minerals may occur in the upper parts of some of these deposits.

The deposits that owe their value chiefly to gold are those at Seven Troughs and at Chafey. Those at Seven Troughs are in Tertiary volcanic rocks; those at Chafey are in Mesozoic volcanic and sedimentary rocks, probably Triassic.

Like the gold deposits, the copper deposits of the region fall into two classes. One of these is exemplified by the deposits southwest of Boyer's ranch in Tertiary andesite, and by those at Red Butte, which are in igneous rocks doubtfully regarded as of Tertiary age. The deposits at Coppereid and Adelaide, on the other hand, are in calcareous sedimentary rocks, probably belonging to the Triassic. They have the mineralogic characteristics of contact metamorphic deposits. Gar-

net, chalcopyrite, pyrrhotite, sphalerite and pyrite are common to both localities. Axinite, fluorite, epidote and specularite occur in the contact zone at Coppereid, but were not noted at Adelaide. At the latter place the altered limestone contains vesuvianite, diopside and orthoclase.

The antimony and quicksilver deposits, with the exception of some stibnite at Seven Troughs, are all, so far as is known, in Triassic or Jurassic rocks, and are supposedly of the same age as the antimonial silver-gold ores. No facts are known, however, that rule out a Tertiary age for some of these deposits.

The nickel and cobalt deposits in Cottonwood Canyon consist of sulpharsenites of nickel (gersdorffite in part), tetrahedrite and some compound of cobalt with sulphur, arsenic or antimony, with the various oxidation products of these minerals. The ores fill small fissures in much altered andesite or andesite breccia cut by diorite, and may be genetically related to the intrusion of the latter rock.

The southern portion of Humboldt County is part of a metallogenetic province characterized chiefly by the prevalence of antimonial ores of silver with numerous and widely scattered deposits of stibnite and cinnabar. There are in addition some deposits of gold-silver, copper and nickel-cobalt ores. Ore deposition probably began immediately after the intrusion of the Triassic and Jurassic sediments in late Mesozoic time by a granodioritic magma, comparable with that which invaded the rocks of the Sierra Nevada at the same period and continued into the Tertiary. The known Tertiary deposits are essentially gold-silver ores and copper ores, but it is possible that some of the other types are also Tertiary.

Refractive Index of Canada Balsam: F. C. CALKINS.

A very convenient and constantly utilized aid to the determination of minerals in thin section being a comparison of their refractive indices with that of Canada balsam, it is obviously important to know as definitely as possible how widely the refringence of balsam in good slides is likely to vary. The published statements regarding this matter, however, are meager and contradictory, and their experimental basis appears in no case to have been recorded. The following experiments were carried out for the purpose of determining the approximate mean and extremes of the refractive index of the balsam in the slides made for the U. S. Geological Survey.

First, the refractive index of balsam (η) was compared with ω of quartz (1.544) in 300 slides from one to eight years old. It was found that η exceeded ω in only one case out of one hundred, except where the cover-glass was sprung away; where η was greater than 1.544 the excess was extremely small and the balsam was noticeably yellow.

The lowest value observed was between γ and β of nearly pure albite, about $1.535 \pm .002$.

Mr. W. T. Schaller supplemented these observations by measurements with an Abbe refractometer on blank preparations representing the condition of the balsam in normal, in undercooked and in overcooked preparations. The extremes found by Mr. Schaller were 1.535 and 1.543, the mean of eleven measurements 1.5393. The refractive index of one sample of highly fluid uncooked balsam was found to be 1.524.

It therefore appears that the mean refractive index of Canada balsam in good petrographic slides is about 1.54, and that it rarely is less than 1.535 or more than 1.545.

Paleozoic Erosion Channels: E. O. ULRICH.

Fossil erosion channels and caverns afford a valuable proof of the repeated emergence of the sea bottom, they being mostly of sub-aerial origin.

Channels and caverns of Pennsylvanian, Mississippian and late Devonian age have been described and figured, but earlier examples, though abundant and of unmistakable origin, have remained but imperfectly known.

Erosion channels may be divided into three classes: superficial, submarine and subterranean. The first class embraces all sub-aerial channels formed by running water, including tidal overflows. The second class embraces all channels produced by currents scouring the sea bottom; these are very rare as strong currents manifestly seldom occur in the shallower epicontinental seas. The third class includes solution cavities and caverns formed in limestones and dolomites by the action of acidulated surface waters.

As illustrating superficial erosion, may be mentioned channels in the Trenton at Trenton Falls, New York, which were probably in the nature of "guts" on ancient tidal flats. Concomitant with the formation of these channels gravitational slumping occurred, resulting in their partial filling with much distorted strata. A doubtful instance of submarine erosion is found in the Fern Glen (Kinderhook) in northern Arkansas, with an overlap of Boone chert. To this same class probably belongs an intraformational erosion surface exhibited by the Lowville near Watertown, N. Y. Most

striking examples of solution cavities and caverns occur in the flanks of the Ozark uplift in Missouri. Some of the caverns are excavated in the pre-Ordovician Jefferson City dolomite, others in Niagara limestone; the filling in either case consisting chiefly of late Devonian and early Mississippian sandstones. Others again occur in late Devonian limestone, while several instances in Ordovician limestone of Lowville and Stones River age were found filled with later Ordovician sediments.

PHILIP S. SMITH,
Secretary

THE 223d meeting of the society was held at the George Washington University on Wednesday evening, November 24, 1909.

Regular Program

Rock Glaciers in Alaska: STEPHEN R. CAPPS.

The rock glaciers, a hitherto undescribed feature, occur in large numbers and in exceptionally perfect development in the area covered by the Nizina Special Map, Copper River region, Alaska. They all head in glacial cirques and extend from these down into the valleys, varying in width from one tenth to three fifths miles, and in length from one half to two and one half miles. The surface slopes range from 9° to 18°. In slopes, shape and surface markings they bear a striking resemblance to glaciers. In the upper portions longitudinal ridges and furrows are conspicuous, while toward the lower ends the ridges become concentric, parallel with the borders of the lower ends of the flows. A few of the rock glaciers actually grade into true glaciers at their upper ends. Most of them, however, show no ice or snow on the surface, the fragmentary rock of which they are composed extending up to the cirque walls above.

All the rock glaciers examined were found to be cemented with interstitial ice, which filled the openings to within a few feet of the surface at their upper ends, but was farther from the surface in the lower ends. This ice has imparted to the mass of rock waste a kind of glacial movement which is thought to be still in operation in many of the flows. The typical rock glaciers differ from true glaciers in that they head in cirques in which there are no perennial snows; in the purely interstitial character of the ice; and in their ability to endure in climatic conditions in which ordinary glaciers can not exist.

Canyon de Chelly, Arizona: M. R. CAMPBELL. (No abstract.)

Geological Observations in Iceland: FRED. EUGENE WRIGHT.

Geologic mapping in Iceland is still in the reconnaisance stage. Most of its geologic features are as yet known only in a general way. Like the Faroe Islands, Iceland consists almost wholly of volcanic rocks (basalt) and associated tuffs and breccias. Thorrodsen has shown that the earliest rocks now exposed are probably of early Miocene age and that volcanic activity has characterized the island since its uplift in early Miocene or late Eocene. Among its most striking structural features is block faulting, but interest in the island centers chiefly in its volcanic and glacial phenomena. Among the former are explosion craters, lava cone craters, crater series along faults, fissure eruptions, secondary craters, etc., in model-like development and on a scale far surpassing that of any other country. Among the latter are the erosional effects of both continental and valley glaciers, especially prominent in north Iceland where the basalt formation is nearly flat-lying and homogeneous in character. The valleys exhibit: U-cross-sections, hanging side valleys, steepening of grade toward valley head with tendency toward cirque development, glacial grooves and markings along valley sides, truncation and alignment of spurs, etc., between tributary valleys, low cigar-shaped spurs at junction of larger tributary valleys attenuated by overriding of glaciers confluent at acute angles. In a country covered with an ice-cap, the surface of the ice sheet is an important plane of reference which in its physiographic effect is often similar to that of a water surface, as sea-level, toward which all exposed land surface tends to be reduced. The mountains and rock cliffs emergent above the ice-sheet undergo rapid changes in temperature with accompanying shattering due to expansion of included moisture in freezing, and tend to break down rapidly and to be reduced to the level of the ice surface. Whatever the nature of the erosional activities going on below the surface of the ice cap, the ultimate result will be a truncation of the mountains at a common level, strongly resembling in appearance an uplifted and dissected peneplain.

FRANCOIS E. MATTHES,
Secretary

AT the 224th meeting of the society, held on December 8, 1909, Mr. Arthur Keith presented the following paper: "The Status of Geologic Names."

The student of stratigraphy in anything except

the most limited way at once encounters the question of names. In the pioneer stage of geology a name is required for each new unit described, since exact correlation with existing names is usually impossible. This is less true of the second stage of geologic work, where information is accumulated and names multiplied. American geology has now advanced to the third or selective stage, where many correlations are certain, and preliminary names are gradually passing.

The most oppressive fact to the student is the flood of names. About 3,500 have now been used in the United States and Alaska, and to them nearly 100 new ones are added yearly. The labor of digesting these seems almost prohibitive to stratigraphic progress. A single name is applied to two or three different units, and for the same unit there may be five or six different names.

The complexity is increased by poor definitions and shifting limits of the units. Limited attempts have been made to reduce and correlate. Individuals and state surveys have done their part locally, the U. S. Geological Survey has issued correlation bulletins covering the United States, and a general committee representing the chief American organizations has recently been formed to make recommendations on names.

The chief attack on the chaos is now being made by the committee on geologic names in the United States Survey. All names used in papers issued by the survey or its members are considered by this committee. Exact definitions and type localities are required for new names, and the use and correlation of old names considered. Comparative harmony is thus secured, the number of new names is kept down, poor uses are rejected and useless names abandoned. The committee takes acount of priority, clearness of definition and locality, and the usage of each term, no one feature being supreme. Various catalogues of the committee cover its own action, the full list of names in use, the names in each system, in each state, and the various columnar sections published in each state. All of these are complete to date except the last, on which work is steadily proceeding, and are available for general consultation. These are leading to a comprehensive correlation of the formations of the United States.

The underlying motive of all this work is utility. A name is given to a stratigraphic unit for convenience in referring to it. If the definition is exact and the use consistent, the idea conveyed will be precise. If it is not precise it is not scientific, and should be avoided as obscuring the mental image. If a geologic name for a unit could be extended over the whole country, the case would be ideal and the image would be called up with the least effort. Many formations and names can be carried far and wide, and in that degree will the alphabet of geology be simplified. To sift and tie together the loose mass of names will cause hardships, but they will be lost sight of in the enormous gain in ease and clearness. The present incubus of names is something to be shaken off at the earliest moment.

At the close of Mr. Keith's address the seventeenth annual meeting of the society was held for the purpose of electing officers, and the following officers were elected for the ensuing year:

President—M. R. Campbell.

Vice-presidents—T. W. Stanton and David White.

Secretaries—Francois E. Matthes and Edson S. Bastin.

Treasurer—C. A. Fisher.

Members at Large of the Council—Geo. H. Ashley, F. B. Van Horn, Geo. W. Stose, A. R. Schultz, W. C. Mendenhall.

PHILIP S. SMITH,
Secretary

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

THE 671st meeting was held in the West Hall of George Washington University on November 20, 1909, President Wead in the chair. Two papers were read:

The First Cruise of the "Carnegie" and her Equipment: Dr. L. A. BAUER, of the Carnegie Institution of Washington.

The Producer Gas Engine on the "Carnegie": Mr. CARL D. SMITH, of the U. S. Geological Survey.

A detailed description was given of the non-magnetic producer gas engine plant installed on the *Carnegie*, and the principles involved in its construction and operation were illustrated by lantern slides. The plant consists essentially of a gas producer and a producer gas engine with the necessary accessories.

This unique engine, which is constructed almost exclusively of non-magnetic materials, is a new departure in marine motive power, both as regards the materials used in its construction and in its application to a sea-going vessel.

For an account of the success already achieved by this plant and its remarkable economy of fuel consumption, see the abstract of the paper by

Dr. L. A. Bauer on "The First Cruise of the *Carnegie* and her Equipment," which will be printed in SCIENCE.

THE 672d meeting was held in Hubbard Memorial Hall on December 4, 1909, President Wead in the chair. The evening was devoted to addresses commemorative of the life and work of Professor Simon Newcomb. Addresses were made by the following persons:

The Right Hon. James Bryce, ambassador from Great Britain; Professor Milton Updegraff, director, Nautical Almanac; Dr. R. S. Woodward, president of the Carnegie Institution of Washington; Dr. L. O. Howard, chief, Bureau of Entomology, Agricultural Department; Professor E. M. Gallaudet, president, Gallaudet College.

At the close of the addresses the following resolutions were read and adopted:

WHEREAS the Philosophical Society of Washington has been deprived by death of the fellowship of Simon Newcomb, and

WHEREAS he was for thirty-eight years one of its active members and twice served as its president, be it

Resolved that the society record its high appreciation of his phenomenal talents, his preeminent attainments and his scholarly discussion of the many topics which his broad sympathies and varied interests proposed for consideration. And be it further

Resolved that this society unite with the learned societies and institutions of the entire world in testifying to the loss to science and high learning which his death occasioned; and that we hereby convey to the bereaved family assurance of our profound sympathy.

R. L. FARIS,
Secretary

THE SOCIETY FOR EXPERIMENTAL BIOLOGY AND MEDICINE

THE thirty-fifth meeting of the society was held at the College of Physicians and Surgeons, October 20, 1909, with President Lee in the chair.

Members present: Auer, Ewing, Famulener, Foster, Gies, Harris, Hatcher, Hunter, Joseph, Lamar, Lee, Levene, Levin, Meltzer, Mayer, Meyer, Morgan, Morse, Murlin, Norris, Noguchi, Opie, Park, Pearce, Rous, Symmers, Schaffer, Stockard, Van Slyke, Wadsworth, Weil, Wolf, Zinsser.

Scientific Program

Charles R. Stockard: "The Influence of Alcohol and other Anesthetics on Developing Embryos."

Richard Weil: "On the Variation in the Resistance of Human Erythrocytes in Disease to Hemolysins, with Especial Reference to Syphilis."

W. Koch and F. W. Upson: "The Distribution of Sulphur Compounds in Brain Tissue."

Robert L. Benson and H. Gideon Wells: "The Study of Autolysis by Physico-chemical Methods."

A. I. Ringer (by invitation): "Influence of Adrenalin in Phlorhizin Diabetes."

Andrew Hunter: "A Method for the Determination of Small Quantities of Iodine in Organic Material."

Sutherland Simpson and Andrew Hunter: "Relations between the Thyroid and Pituitary Glands."

Peyton Rous: "Parabiosis as a Test for Circulating Antibodies in Cancer."

Jean V. Cooke (by invitation): "The Excretion of Calcium and Magnesium after Parathyroidectomy."

Hideyo Noguchi: "Non-fixation of Complement."

Hideyo Noguchi: "The Fate of So-called Syphilitic Antibody in the Precipitin Reaction."

Thorne M. Carpenter and John R. Murlin: "The Energy Metabolism of Parturient Women."

Alfred G. Mayer: "The Relation between Ciliary and Muscular Movements."

EUGENE L. OPIE,
Secretary

THE AMERICAN CHEMICAL SOCIETY NORTHEASTERN SECTION

THE ninety-fifth regular meeting of the section was held at the Twentieth Century Club, Boston, on November 26. The annual election of officers took place. Dr. P. A. Levene, of the Rockefeller Institute for Medical Research, in an address on "The Biochemistry of Nucleic Acids," described how the structure of these compounds had been determined by a study of the cleavage products produced by hydrolysis under various conditions.

Dr. H. A. Torrey, of Harvard University, addressed the section on "Alkali-insoluble Phenols. Does structural chemistry explain them?" After having shown that several rather obvious hypotheses as to the relation of structure of certain phenols to their action with alkalies were untenable, the speaker offered the explanation that the unexpected action of these substances might be due to the existence of an equilibrium between a phenol and quinoid form.

K. L. MARK,
Secretary